NELUMBO 56 : 291 - 341, 2014

ALGAL DIVERSITY IN THE STREAMS AND WATERFALLS OF EASTERN AND NORTH-EASTERN REGION OF INDIA

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ABSTRACT

Two hundred fourteen species of algae were recorded from 12 mountain streams of Odisha and 21 streams and waterfalls of the Eastern Himalayan region covering West Bengal, Sikkim, Arunachal Pradesh, Nagaland and Mizoram. Of these Chlorophyta (39), Cyanophyta (31), Heterokontophyta (24) and Euglenophyta (3) were specifically from the streams in Odisha whereas Cyanophyta (43), Chlorophyta (34) and Bacillariophyceae (26) were from the streams and waterfalls of the eastern Himalayan region. The diversity of algae in these two regions of eastern India differing in topography and climatic regime showed a wide variation of occurrence of taxa in these specialized and mostly unpolluted habitats. Only 14 species of algae of which *Phormidium grnulatum, Calothrix fusca, Dichothrix orsiniana, Nostoc commune* under Cyanophyta, *Spirogyra maravillosa, Staurastrum bieneanum* var. *ellipticum, Stigeoclonium longipilum, Oedogonium wyliei* under Chlorophyta and *Fragillaria virescence, Synedra ulna, Synedra ulna* var. *aequalis, Synedra ulna* var. *amphirhynchus, Synedra ulna* var. *oxyrhynchus, Cymbella tumida* under Bacillariophyceae of Heterokontophyta were recorded in certain streams of both the regions . Of these 214 algal taxa, 97 were recoded first from the Eastern and North-eastern region.

Keywords: Algae, streams, waterfalls, Odisha, Himalayas, North-eastern states

INTRODUCTION

Very little work has been done in India on documentation of algal flora in the lotic waters, especially in the mountain streams. Due to fast flow of water in such remote areas in hilly regions away from human habitation, seldom algal mats are seen in naked eye occurring in these springs. Literature survey showed that only a dozen streams in Maharastra (Gonzalves & Gandhi, 1952; 1954, 1962), Rajasthan (Gandhi, 1955), Karnataka (Gandhi, 1959, 1960), Kerala (Pugazhendi & al., 2009), Assam (Saha & al., 2007) and Odisha (Jena & al., 2006a, b; Dey & al., 2008) have been sampled for occurrence of algae. Even in these reports Gandhi either alone or with Gonzalves surveyed 9 streams in three states and Pugazhendi & al., (2009) two streams in Kerala documenting 263 species of diatoms under Heterokontophyta and they have not reported other algal species from these streams. Saha & al., (2007) documented only Cyanophycean forms (Cyanobacteria) belonging to 29 species in few streams of Kakoijana reserve forest, Assam. Jena & al., (2006a) and Dey & al., (2008) surveyed the streams of Similipal Biosphere Reserve in Odisha and reported 14 Cyanophyta, 23 Chlorophyta and 1 Diatom. Though there are few other records of algae in streams of different regions of India, either the name of the stream was not mentioned or how many locations of a particular stream were sampled which would represent algae of mountain streams was not clear (Parukutty, 1939; Prasad & Jaitly, 1985; Anand & Sharma, 1998; Joseph & Joseph, 1999; Nandi & Rout, 2000; Kumar & Rai, 2005). The documentation in unexplored habitats is important, especially from mountain streams which would have a vast wealth of algae so far not reported. Mountain streams of Himalayan region are important as these are unexploited, pristine habitats with less human activity, characterized by low temperature up to sub-zero in certain times of a year, and also is considered as an important biodiversity hot spot covering Indo-Burma region. Hence documentation and comparison of diversity of algal species occurring in these locations with those springs of plains, especially of Odisha state characterized by undulating plateau of Eastern ghats and rich with lotic water bodies was carried out for generating first comprehensive information on the algae these specialized lotic water bodies of Eastern and North-eastern region of region of India.

MATERIALS AND METHODS

Algal samples were collected from the streams and water falls of the Eastern and North-eastern region of India including the state of Odisha, West Bengal, Sikkim, Arunahal Pradesh, Mizoram and Nagaland during the

Date of publication: 30th December, 2014 Received : 8-8-2013 ◆ Accepted : 23-12-2013 © Botanical Survey of India, 2014

Table1 : List of the collection sites in the mountain streams of Eastern and North-eastern region of India showing latitude, longitude, date of collection, voucher number, habitat and mode of occurrence of algae.

Sl. No.	Place of collection in different states	Longitude & Latitude	Date of Collection	Occurrence	Habitat	Voucher No.
Odisha state and the district where the stream is located						
1	Barunei, Khurda	20º09'40.4”N 85º38'52.4”E Alt. 102 ft	17.05.08	Rock surface in stream, on cemented wall of temple, bark	Stream	1492-1496
2	Narayani, Khurda	20º09'40.1”N 85º38'50.2”E Alt. 102 ft	17.05.08 02.10.08	Epilithic, floating mass, filaments, planktonic and epipelic	Stream	1497-1502 1866-1878
3	Nirmalajhar, Ganjam	20º09'40.1”N 85º04'04.07”E Alt. 107 ft	17.05.08	Stream, Floating, Slimy mat on rock Surface	Stream	1503-1506
4	Harishankar, Balangir	20º16'18.1”N 82º51'37.8”E Alt. 760 ft	27.07.08	Epilithic and Planktonic	Stream	1646-1652
5	Pradhanpat, Deogarh	20º51'18.1”N 82º51'38.0”E Alt. 760 ft	28.07.08	Epilithic biofilm and planktonic	Waterfall	1653-1658
6	Sitakund, Mayurbhanj	21º55'36.20"N 86º34'18.67"E Alt. 943 ft	06.10.08	Filamentous, Epilithic	Stream	2033-2040
7	Ghagara, Keonjhar	21º36'20.6”N 85º33'33.5”E Alt. 382 ft	25.11.08	Epilithic, Planktonic Filamentous	Waterfall	2067-2092
8	Furlijharan, Kalahandi	19º47'04.2”N 83º06'45.6”E Alt. 316 ft	23.03.09	Filamentous, Epilithic, Planktonic	Waterfall	2382-2399
9	Nrushingha-nath, Baragarh	20º55'71.7”N 82º48'45.22"E Alt. 972 ft	18.09.10	Epilithic biofilm, benthic and filamentous mat.	Stream	2652-2673
10	Devkund, Mayurbhanj	21º42'28.2”N 86º26'37.63"E Alt. 1198 ft	06.01.11	Epilithic, Planktonic and benthic	Stream	4518-4525
11	Panchalingeswar, Balasore	23º41'07.4"N 87º40'45.3"E Alt. 225ft	20.11.11	Benthic, epilithic biofilm and epilithic filamentous mat	Stream	4610-4623
West Bengal state and the district where the stream is located						
1	Chitrey, Kalimpong	27º03'41.7”N 88º25'40.1”E Alt 5554 ft	08.09.08	Epilithic, Floating Planktonic	Waterfall	1750-1760
2	Way to Tiger hill, Darjeeling	26º59'41.8”N 88º17'06.6”E Alt. 8523 ft	10.09.08	Stream, epilithic, Filamentous	Stream	1762-1765
3	Gangamaya Park Darjeeling	27º02'13.4”N 88º13'55.1”E Alt 8364 ft	10.09.08	Epilithic	Stream	1766-1771
4	Chunnu summer fall, Darjeeling	27º01'30.8”N 88º14'17.3”E Alt. 5044 ft	10.09.08	Epilithic, Floating	Waterfall	1772-1777
Sikkim state and the district where the stream is located						
1	Hanuman tok, East District	27º20'43.6”N 88º37'59.4”E Alt. 6435 ft	12.09.08	Epilithic, Filamentous	Waterfall	1779-1784
2	Kyongnosola, East District	27º22'20.3”N 88º40'33.2”E Alt 8394 ft	12.09.08	Epilithic, slimy mat	Waterfall	1785-1790

Sl. No.	Place of collection in different states	Longitude & Latitude	Date of Collection	Occurrence	Habitat	Voucher No.
3	Ban Jhagri, East District	27º21'06.5”N 88º36'43.2”E Alt. 5826 ft	13.09.08	Epilithic, On sand and Mud surface	Waterfall	1791-1797
4	Pastanga, East District	27º16'55.2”N 88º38'30.0”E Alt. 4535 ft	14.09.08	Epilithic and filamentous	Waterfall	1798-1809
5	Ranipool, East District	27º16'54.6”N 88º35'54.4”E Alt. 2749 ft	14.09.08	Epilithic, blue green	Stream	1810-1813
6	Teesta at Lachung, North District	27º41'20.6"N 88º44'34.7"E Alt. 8592 ft	14.06.10	Epilithic, planktonic and biofilm.	Waterfall	2531-2542
7	Stream in Chungthang, North District	27º36'00.41"N 88º38'50.1"E Alt. 5364 ft	15.06.10 17.06.10	Epilithic biofilm, submerged fil	Waterfall	2551-2557 2563-2570
8	Teesta at Zero point, North District	27º53'59.5"N 88º42'21.6"E Alt. 14930 ft	16.06.10	Epilithic biofilm in stream	Stream	2558-2562
Nagaland state and the district where the stream is located						
1	Pherem, Dimapur	25º54' 47.1"N 93º44' 35.9"E Alt. 423ft	17.02.11	Epipsammic, floating filamentous, benthic, and planktonic.	Stream	2987-2993
Arunachal Pradesh state and the district where the stream is located						
1	Sengay, West Kameng	27º26' 53.3"N 92º07' 04.4"E Alt. 9223 ft	29.10.10	Epilithic, filamentous mat and planktonic.	Stream	2684-2688
2	Jaswantgar, West Kameng	27º30' 56.5"N 92º04' 58.4"E Alt. 13036 ft	29.10.10	Epilithic, filamentous mat and planktonic.	Stream	2694-2698
3	Doimukh, Papum Pere	27º18' 20.6"N 93º48' 22.7"E Alt. 2297ft	03.11.10	Epilithic, Benthic and planktonic.	Stream	2765-2767
Mizoram state and the district where the stream is located						
1	Sirang, Aizawl	23º45' 03"N 23º48' 48"E	23.03.08	Bottom soil	Stream	1416-1419
2	Phunchawan, Lunglei	92º37' 42"N 92º43' 28"E	24.03.08	Waterfall	Waterfall	1420

period from May, 2008 to January, 2012. The GPS data of each collection site, type of the habitat, modes of occurrence of algae and the V.N.of the samples are given in Table-1. The algae occurred as epiphytic, epizoic, epilithic, epipsammic, epipelic etc. were scrapped from their substratum using forcep or scalpel, needle and/or tooth brush. Benthic algae were collected using Pasteur pipette. Planktonic samples were collected using plankton net of 45 µm pore size. All the samples were stored in sterile specimen tubes and brought to the laboratory in a cool ice chest for further analysis. For preservation the samples were fixed with 4 % formaldehyde. Lugol's Iodine solution was also used on spot to immobilize the cells to facilitate microscopic observation. Microphotographs were taken in a Olympus BX41 fitted with Nikon Coolpix 4500 digital camera. Several monographs were used to identify the taxa under different Divisions/ Phylums of algae. These were: for Cyanophyta, Geitler (1925), Desikachary (1959), Komárek & Anagnostidis (1998, 2005), for Chlorophyta, Turner (1892), West & West (1904, 1905, 1908, 1912), West *& al.* (1923), Randhawa (1959), Ramanathan (1964), Philipose (1967), Hindák (1977, 1980, 1984, 1988), Gonzalves (1981), Komárek & Fott (1983),

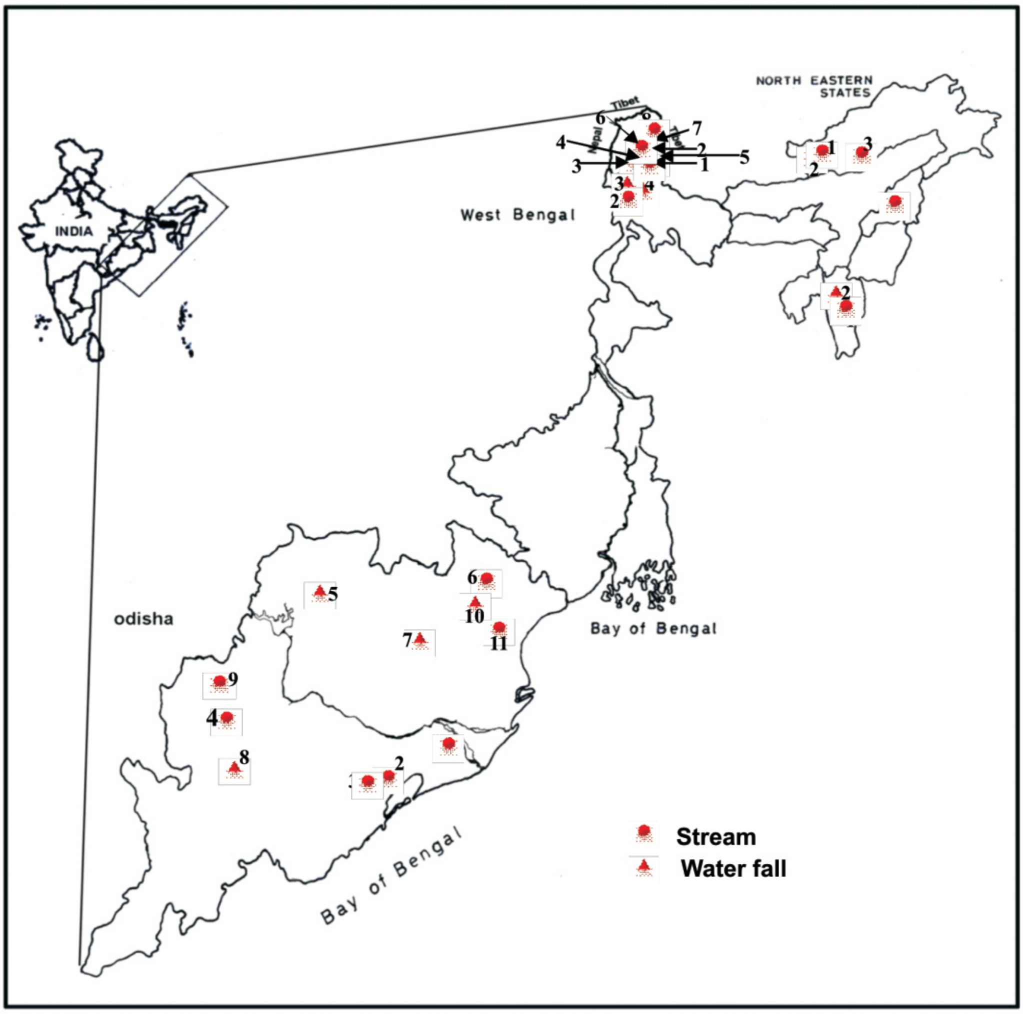

Fig 1: Map showing sampling sites from streams and waterfalls of Eastern and North-eastern region of India.; **Odisha: 1.** Barunei; **2.** Narayani, Khurda; **3.** Nirmalajhara, Ganjam; **4.** Harishankar, Balangir; **5.** Pradhanpat, Deogarh; **6.** Sitakund, Mayurbhanj; **7.** Ghagara, Keonjhar; **8.** Furlijharan, Kalahandi; **9.** Nrushinghanath, Baragarh; **10.** Devkund, Mayurbhanj; **11.** Panchalingeswar, Balasore; **West Bengal : 1.** Chitrey; **2.** Way to Tiger hill, Darjeeling; **3.** Gangamaya Park, Darjeeling; **4.** Chunnu summer fall, Darjeeling; **Sikkim: 1.** Hanuman tok, East district; **2.** Kyongnosola, East district; **3.** Ban Jhagri, East district; **4.** Pastanga, East district; **5.** Ranipool, East district; **6.** Lachung, North district; **7.** Chungthang reserve forest, North district; **8.** Teesta at Zero point, North district; Nagaland; **1.** Pherem, Dimapur.; **Arunachal Pradesh: 1.** Sangey, West Kameng; **2.** Jaswantgarh, West Kameng; **3.** Doimukh, Papum Pere; **Mizoram: 1.** Sirang, Aizawl; **2.** Phunchawang, Lunglei.

Krishnamurthy (2000), for Euglenophyta, Huber – Pestalozzi (1955), Wołowski & Hindák (2005) and for Bacillariophyceae under Heterokontophyta, Kützing (1865), Huber – Pestalozzi (1942), Desikachary (1989), Desikachary & Devi (1986), Desikachary & Prema (1987) and Desikachary *& al.* (1987). The Cyanophyta/Cyanoprokaryota taxa were classified following Komárek & Anagnostidis (1989, 1998 and 2005). For algal taxa belonging to Chlorophyta, Euglenophyta and Heterokontophyta the classification of Lee (1999) was followed.

Systematic enumeration
(* first record for Eastern and North-eastern region).

CYANOPHYTA (CYANOPROKARYOTA/CYANOBACTERIA)

1. **Aphanothece microscopica** Näg.; Komárek and Anagnostidis 1998, p. 84, fig. 72, 73 **(Pl. 5, Fig. 1)**

Thallus colonial, mucilaginous, irregular with dense colorless mucilaginous outline, cells ellipsoidal or oval, 5 µm long, 5-3 µm broad, cells with thin individual mucilaginous outline, unicellular or two celled during cell division, cell content homogenous or with few aerotopes.

Sikkim: Lachung. Blackish to grey epilithic biofilm, 14.06.2010, V.N. – 2540.

2. **Aphanothece saxicola** Näg.; Komárek and Anagnostidis 1998, p. 82, fig. 69 a; Synonym - *Aphanothece subachroa* Hansg. **(Pl. 5, Fig. 2)**

Thallus mucilaginous, colorless, cells oval to cylindrical with rounded ends, 2-3 µm broad and 5 µm long, single, cell content light blue green.

Sikkim: Pastanga (20°C, pH - 6.7). Epilithic on moist rocks, 14.09.2008, V.N. – 1801; Sikkim: Hanuman tok, Gangtok (18°C; pH - 6.8). Floating mass, 12.09.2008, V.N. – 1783.

3. **Gloeothece rupestris** (Lyn.)Born. & Wittr. & Nordst. ; Komárek and Anagnostidis 1999, p. 98, fig. 97; Synonym- *Gloeohece rupestris f. maxima* (West) Hollerb. in Elenk. **(Pl. 5, Fig. 3)**

Thallus bluish green, colony 2-4 celled, cells elliptical, cell content homogenous, mucilage hyaline, stratified, cells 5-6 µm long, 4 µm broad, colony 10-15 µm in diameter.

Sikkim: Lachung. Blackish to grey epilithic biofilm, 14.06.2010, V.N. – 2539.

4. **Synechocystis pevalekii** Eicegović; Komárek and Anagnostidis 1999, p. 143, fig. 163 **(Pl.5, Fig. 4)**

Thallus bluish green, unicellular or colonial, colony mucilaginous, hyaline, cells spherical to hemispherical during cell division, cell content granulated with aerotopes, cells 5 µm in diameter.

Sikkim: Lachung. Blackish to grey epilithic biofilm, 14.06.2010, V.N. – 2534.

5. **Merismopedia glauca** (Ehrenb.) Näg.; Desikachary 1959, p. 155, pl. 29, fig. 5; Basionym – *Gonium glaucum* Ehrenb.; Synonym - *Gonium glaucum* Ehrenb., *Merismopedia aeruginea* Brébisson, *Merismopedia nova* Wood; **(Pl.1, Fig. 1)**

Colonies light blue green, almost rectangular with slightly sinuate margin; hemispherical cells, 1-2 µm in diameter; colony is 64 celled; colony is 14-15 µm long and 16-17 µm broad.

Odisha: Huluhula, Ganjam. Epipsammic mat, 20.04.2008, V.N. – 1488; Odisha: Phurlijharan, Kalahandi (20°C, pH-6.2). Epilithic biofilm with filamentous algae, 23.03.2009, V.N. – 2386.

6. **Gloeocapsa crepidinum** Thur.; Desikachary 1959, p. 117, pl. 27, fig. 4; Basionym – *Protococcus crepidinum* Thur. **(Pl.5, Fig. 5)**

Thallus colonial, gelatinous, blue green or grey green, cells rounded 2-4 in groups, thin sheathed, cells 5 µm in diameter.

West Bengal: Chitrey, Kalimpong (29°C; pH - 6.8). Slimy epilithic biofilms, 08.09.2008, V.N.– 1755.

7. **Gloeocapsa gelatinosa** (Meneghini) Kütz.; Komárek and Anagnostidis 1998, p. 239, fig. 308 **(Pl.5, Fig. 6)**

Colonies microscopic later and macroscopic, olive green, composed from aggregated subcoloneis, mucilaginous envelops not very wide, colorless, enveloping solitary cells or groups of cells, intensely stratified, cells spherical, blue green 3-5 µm diameter.

Sikkim: Pastanga (20°C, pH - 6.7). Epilithic on moist rocks, 14.09.2008, V.N. – 1801.

8. **Gloeocapsa kützingiana** Näg.; Komárek and Anagnostidis 1998, p. 258, fig. 335 **(Pl.5, Fig. 7)**

Colonies microscopic, irregular, mucilaginous, cells spherical or ellipsoidal, 3 µm in diameter, enveloped by widen mucilaginous sheaths.

Sikkim: Pastanga (29°C, pH - 6.7). Epilithic on moist rocks, 14.09.2008, V.N. – 1805. Sikkim: Ranipool, Gangtok (20°C, pH - 6.7). Green filamentous mat, 14.09.2008, V.N. – 1809; Sikkim: Lachung. Blackish to grey epilithic biofilm, 14.06.2010, V.N. – 2534.

9. **Gloeocapsa punctata** Näg.; Komárek and Anagnostidis 1999, p. 239, fig. 309 **(Pl. 5, Fig. 8)**

Thallus bluish green, colonial, colony four celled, mucilaginous, mucilage hyaline, stratified, cell content homogenous with individual sheath, cells 6-8 µm in diameter, colony 20-22 µm diameter.

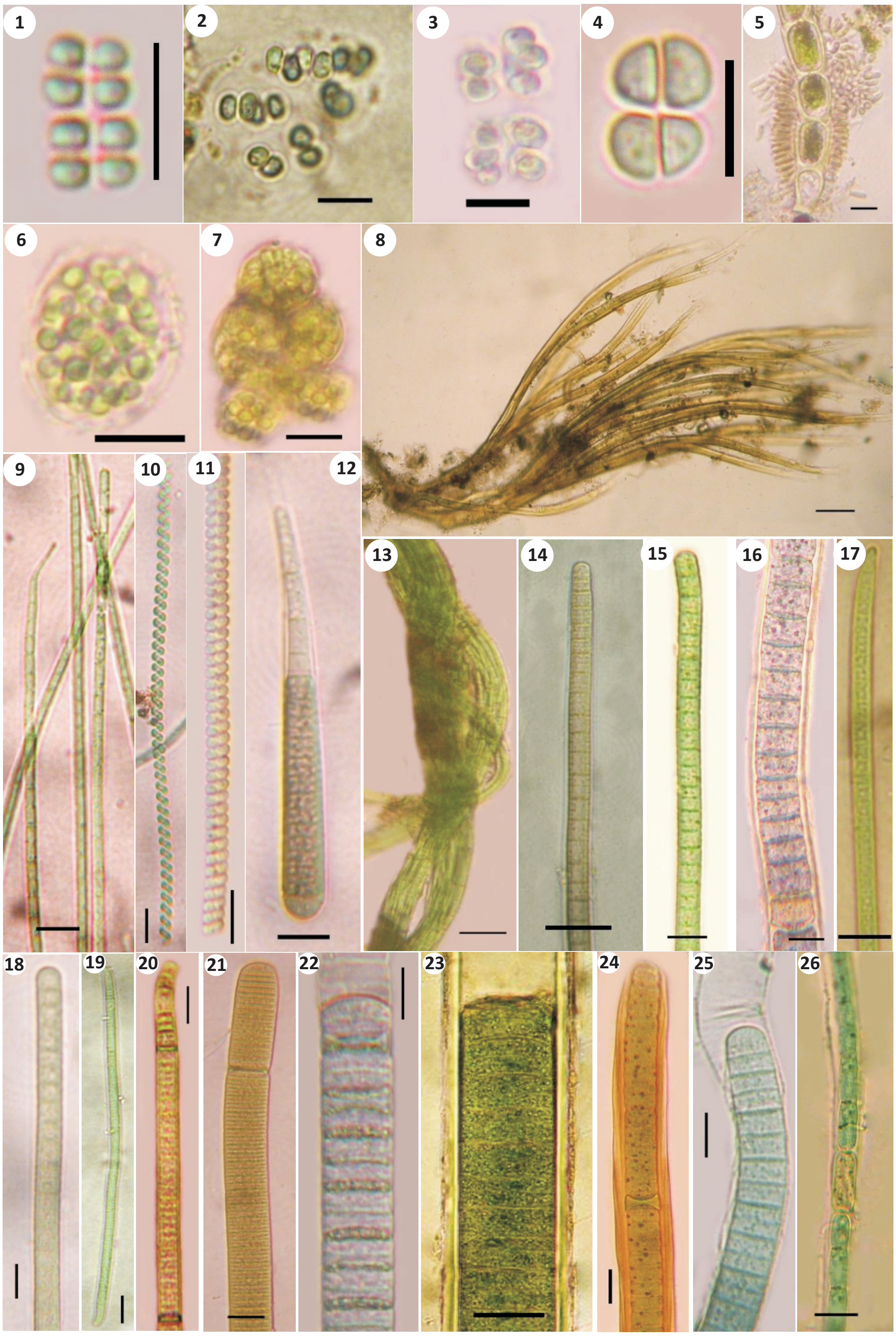

Plate 1 : (Fig.1-26): 1. *Merismopedia glauca;* **2.** *Chroococcus dispersus;* **3.** *Chroococcus prescottii;* **4.** *Cyanosarcina fontana;* **5.** *Geitleribactron periphyticum;* **6.** *Chroococcidiopsis fissurarum;* **7.** *Pleurocapsa concharum;* **8.** *Homoeothrix poljanskii;* **9.** *Geitlerinema acutissimum;* **10.** *Spirulina major;* **11.** *Spirulina subsalsa;* **12.** *Homoeothrix juliana;* **13.** *Trichocoleus erectiusculus;* **14.** *Phormidium autumnale;* **15.** *Phormidium koprophilum;* **16.** *Phormidium puteale;* **17.** *Phormidium terebriforme;* **18.** *Phormidium tergestinum;* **19.** *Oscillatoria acuta;* **20.** *Osillatoria agardhii;* **21.** *Oscillatoria limosa;* **22.** *Lyngbya hieronmusii;* **23.** *Lyngbya majuscula;* **24.** *Lyngbya sordia;* **25.** *Lyngbya splendens;* **26.** *Aulosira bombayensis.* (Scale bar : Figs. 1-7 & 9-26=10µm; Fig. 8= 50 µm)

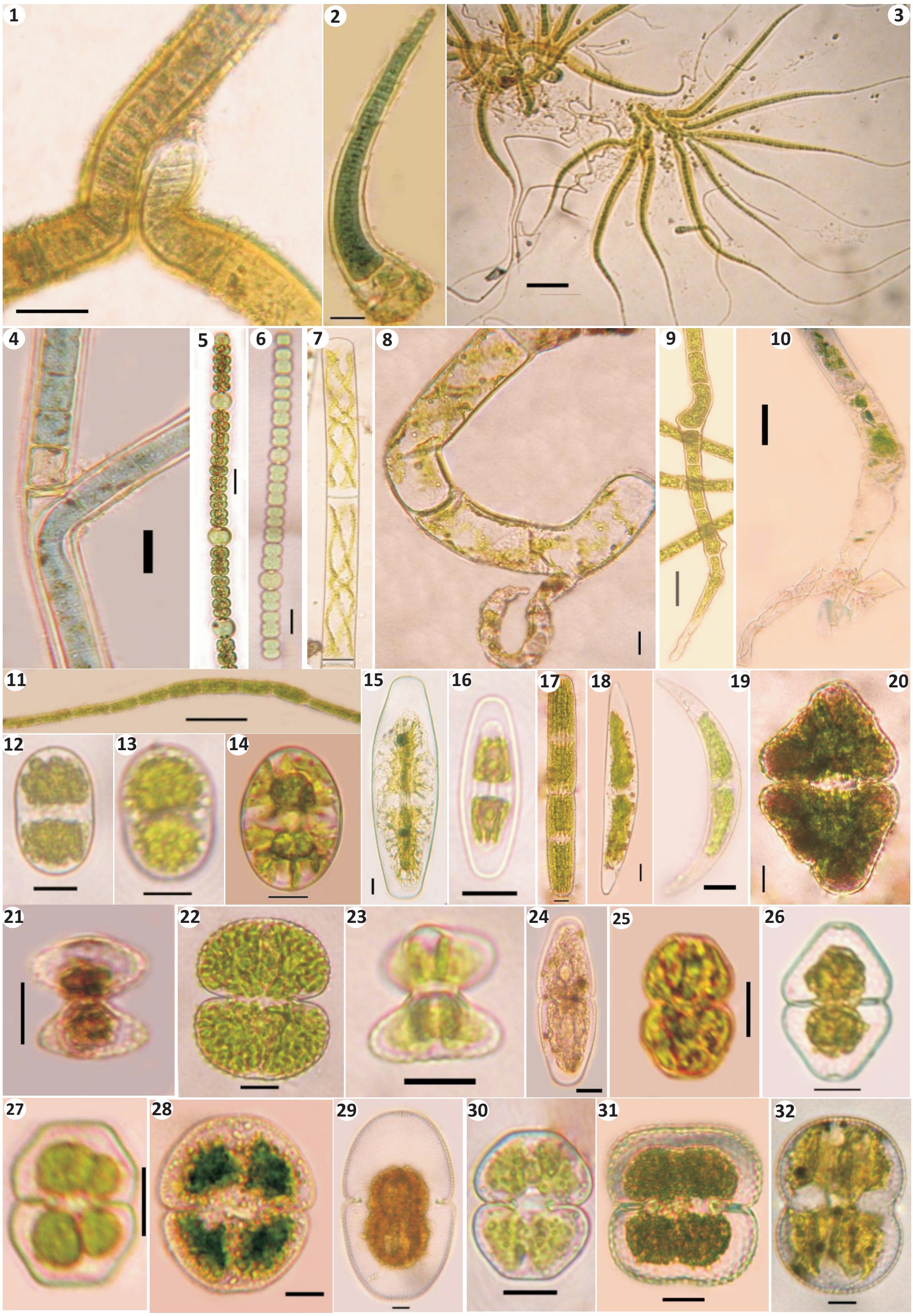

Plate-2 (Fig.1-32): 1. *Scytonema saleyeriense* var. *indica;* **2.** *Calothrix fusca;* **3.** *Rivularia mesenterica;* **4.** *Tolypothrix robusta;* **5.** *Anabaena affinis;* **6.** *Anabaena constricta;* **7.** *Spirogyra pseudoreticulata;* **8.** *Spirogyra rhizoids;* **9.** *Rhizoclonium hieroglyphicum;* **10.** *Rhizoclonium pachydermum;* **11.** *Sirocladium kumaoense;* **12.** *Cylindrocystis brebisonii;* **13.** *Cylindrocystis crassa;* **14.** *Cylindrocystis obesa;* **15.** *Netrium digitus;* **16.** *Penium navicula;* **17.** *Penium margaritaceum;* **18.** *Closterium acerosum;* **19.** *Closterium calosporum;* **20.** *Euastrum gangense;* **21.** *Staurastrum bienaeanum* var. *ellipticum;* **22.** *Staurastrum donardense;* **23.** *Staurastrum striolatum;* **24.** *Cosmarium angulatum;* **25.** *Cosmarium difficile* var. *sublaeve;* **26.** *Cosmarium granatum* var. *ocellatum;* **27.** *Cosmarium inaequalipellicum;* **28.** *Cosmarium lundellii* var. *ellipticum;* **29.** *Cosmarium maculiforme;* **30.** *Cosmarium nitidulum;* **31.** *Cosmarium quadrum* var. *andamanicum;* **32.** *Cosmarium turgidum* var. *subrotundatum.* (Scale bar: Figs. 1,2 & 4-32=10µm; Fig.3=30 µm)

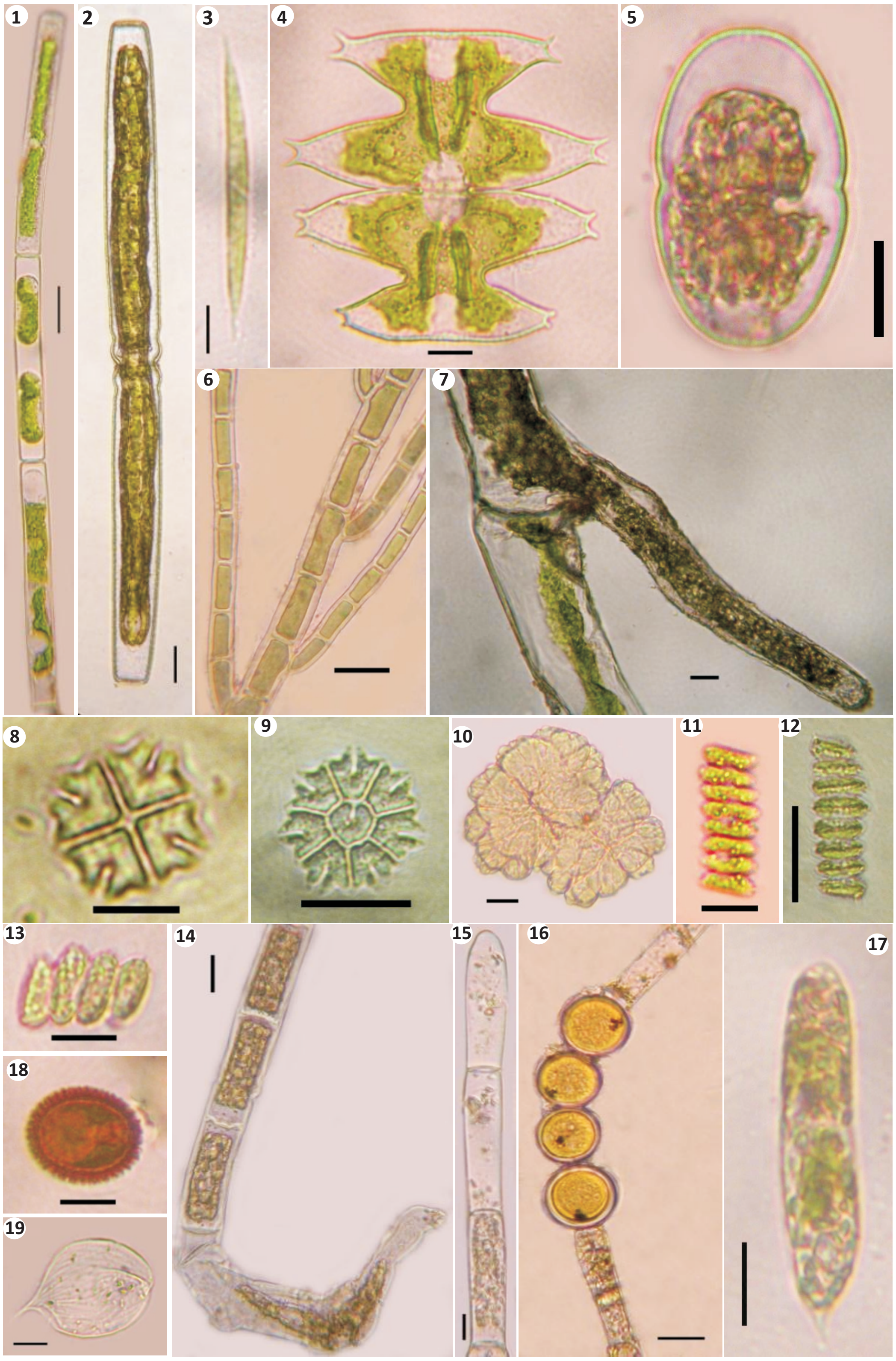

Plate-3 (Fig.1-19): 1. *Gonatozygon kinahani;* **2.** *Pleurotaenium ehrenbergii;* **3.** *Micrasterias pinnatifida;* **4.** *Actinataenium cucurbita;* **5.** *Stigeoclonium longipilum;* **6.** *Cladophora glomerata;* **7.** *Pediastrum tetras;* **8.** *Pediastrum tetras* var. *tetraodon;* **9.** *Botryococcus braunii;* **10.** *Scenedesmus armatus* var. *armatus;* **11.** *Scenedesmus brasiliensis* var. *brasiliensis;* **12.** *Scenedesmus ellipticus;* **13.** *Monoraphidium griffithii;* **14.** *Microspora indica;* **15.** *Oedogonium tiffanyi;* **16.** *Oedogonium wyliei;* **17.** *Euglena gracilis;* **18.** *Phacus pleuronectes;* **19.** *Trachelomonas bacilifera* var. *minima*
(Scale bar: Figs. 1-19=10µm)

Sikkim: Lachung. Blackish to grey epilithic biofilm, 14.06.2010, V.N. – 2539.

10. **Chroococcus dispersus** (Keissl.) Lemmerm.; Prescott 1961, p. 447, pl. 100, fig. 7; Basionym – *Chroococcus minor* var. *disperses* Keissl.; Synonym - *Chroococcus limneticus* var. *subsalsus* Lemmerm., *Gloeocapsa minor* f. *dispersa* (Keissl.) Hollerb. **(Pl.1, Fig. 2)**

Free floating, flattened, irregular shaped colonies of 8 spherical cells, arranged in a small cluster, evenly distributed at some distance from one another individual cell sheath not found, cell contents bright blue green, 3.5 – 4.5 µm in diameter.

Odisha: Sitakund, Mayurbhanj. Epilithic in stream, 06.10.2008, V.N. - 2034.

11. ***Chroococcus prescottii** Drouet & Daily; Komárek and Anagnostidis 1998, p. 288, fig. 377; Synonym- *Eucapsis alpine* sensu Siemińska **(Pl.1, Fig. 3)**

Thallus bluish green, colony microscopic, irregular in outline, cells oval with mucilaginous envelope, cells 6.25 µm long, 2.5 µm broad.

Odisha: Harishankar, Balangir. Epilithic, 27.07.2008, V.N.– 1644.

12. **Gloeocapsopsis crepidinum** (Thur.) Geitler & Komárek; Komárek and Anagnostidis 1998, p. 275, fig. 361; Basionym– *Protococcus crepidinum* Thur.; Synonym - *Protococcus crepidinum* Thur., *Gloeocapsa crepidinum* (Thur.) Thur., *Pleurocapsa crepidinum* (Thur.) Ercegovic **(Pl. 5, Fig. 9)**

Colonies large, gelatinous, irregular, cell hemispherical to spherical, 4.5-5 µm in diameter, envelope thin, colorless and diffluent, not lamellate, hyaline, cell content homogenous.

Sikkim: Chungthang. Epilithic biofilm, 15.06.2010, V.N.– 2554, 2555.

13. **Gloeocapsopsis magma** (Bréb.) Komárek & Anagnostidis; Komárek and Anagnostidis 1999, p. 279, fig. 364 **(Pl. 5, Fig. 10)**

Colony multicellular, brownish, divergent, cells arranged compactly with mucilage, cells hemispherical, cell division transverse, 3.5 µm in diameter.

Sikkim: Lachung. Blackish to grey epilithic biofilm, 14.06.2010, V.N. – 2538.

14. ***Cyanosarcina fontana** Kovácik; Komárek and Anagnostidis 1998, p. 316, fig. 421 a **(Pl.1, Fig. 4)**

Colony macroscopic, subsperical to irregular, cell clusters covered by thin, firm, and colorless mucilaginous envelop; cells hemispherical, 3.8 µm in diameter.

Odisha: Harishankar, Balangir (pH - 6.7). Bluish green epilithic biofilm, 27.07.2008, V.N.– 1647.

15. **Cyanosarcina spectabilis** (Geitler) Kovácik, Komárek and Anagnostidis 1999, p. 316, fig. 422; Synonym- *Myxosarcina spectabilis* Geitler **(Pl. 5, fig. 11)**

Thallus bluish green, colonial, colony with thick mucilage, cell divides transversely, hemispherical during cell division, cell content homogenous, cells 1.5-2µm diameter, colony 8-12 µm diameter.

Sikkim: Chungthang. Blackish green slimy mat, 15.06.2010, V.N.– 2552.

16. ***Geitleribactron periphyticum** Komárek; Komárek and Anagnostidis 1998, p. 360, fig. 475 **(Pl.1, Fig. 5)**

Cells periphytic, slitary and colonial, forming dense gtoups attached to substratum, cells straight, slightly arcuate or cylindrical, attenuated towards base with mucilaginous pads, end part of the cell rounded, cells 4.5 - 10 µm long, 1.5-2 µm broad, cell content homogenous.

Odisha: Phurlijharan, Kalahandi(20°C, pH-6.2). Strongly attached filamentous patch on rock surface, 23.03.2009, V.N.- 2380.

17. ***Chamaesiphon confervicola** var. **elongatus** (Nordst.) Kann; Komárek and Anagnostidis 1998, p. 381, fig. 498 **(Pl.5, Fig. 12)**

Thallus grey green, cells solitary or in a group; sometimes parallel to each other or more, aggregated in a group, attached to the substrate, more or less club shaped or almost cylindrical, slightly curved, rounded at the apex, clearly narrowed to the bluntly pointed base, usually withdrawn from the base of pseudovagina; cell 35-55 µm long and 4.2-6 µm without pseudovagina and upto 10 µm broad with pseudovagina.

Sikkim: Hanumantok, Gantok (14°C, pH - 6). Epilithic thick mat in stream, 12.09.2008, V.N. – 1784.

18. ***Chroococcidiopsis fissurarum** (Ercegović) Komárek & Anagnostidis; Komárek and Anagnostidis 1998, P.423, Fig. 551; Synonym- *Pleurocapsa fissurarum* Ercegović **(Pl.1, Fig. 6)**

Colony microscopic, 18-20 µm in diameter, mucilage hyaline, cells rounded to oval 2-3 µm diameter.

Odisha: Harishankar, Balangir (pH - 6.7). Bluish green epilithic mass under flowing water, 27.07.2008, V.N.– 1650.

19. **Chroococcidiopsis kashayi** Friedmann; Komárek and Anagnostidis 1998, p. 423, fig. 553 **(Pl.5, Fig. 13)**

Cells in a group, more or less spherical, colony spherical, enveloped by sheath, cells 3 µm broad, 4 µm long, colony 21 µm in diameter.

Sikkim: Banjhagri fall, Gangtok (22°C, pH - 6). Blue green to grey green, slimy epilithic biofilm, 13.09.2008, V.N.– 1793; West Bengal: Rock garden, Darjeeling (20°C, pH - 6.8). Strongly attached epilithic biofilms, 10.09.2008, V.N. – 1775; Sikkim: Chungthang. Bluish green to grey green slimy epilithic biofilm, 17.06.2010, V.N. – 2570.

20. ***Pleurocapsa concharum** Hansg.; Komárek and Anagnostidis 1998, P.465, Fig. 611 **(Pl.1, Fig. 7)**

Thallus colonial, microscopic, colony 15-20 µm in diameter, cells rounded to oval, cell content homogenous.

Odisha: Harishankar, Balangir (pH - 6.7). Bluish green epilithic mass under flowing water, 27.07.2008, V.N.– 1650.

21. **Pseudanabaena limnetica** (Lemmerm.) Komárek; Komárek and Anagnostidis 2005, p. 84, fig. 60; Basionym - *Oscillatoria limnetica* Lemmerm.; Synonym - *Oscillatoria limnetica* Lemmerm. **(Pl. 5, Fig. 17)**

Trichome bluish green, solitary, straight, cross walls hyaline, translucent, slightly constricted, without aerotopes, not attenuated at the ends; cells long, cylindrical, 2.5 µm broad , 8-10 µm long , cell contents homogenous, apical cells rounded.

Nagaland: Pherem, Planktonic, 18.02.2011, V.N.– 3027.

22. **Geitlerinema acutissimum** (Kufferath) Anagnostidis; Komárek and Anagnostidis 2005, p. 126, fig. 133; Synonym - *Oscillatoria acutissima* Kufferath; *Phormidium acutissima* (Kufferath) Anagnostidis & Komárek **(Pl.1, Fig. 9)**

Thallus bluish green, under flowing stream, trichome straight, motile, constricted at cross walls, attenuated into a bent acute apex, cells longer than broad, 2.5 µm broad, 3.75-5.25 µm long, cell content with cyanophycean granule.

Odisha: Phurlijharan, Kalahandi (20°C, pH-6.2). Epipelic mat in a rock crevice, 23.03.2009, V.N.- 2381.

23. **Spirulina major** Kütz. ex Gom.; Komárek & Anagnostidis 2005, p. 148, fig. 173; Synonym – *Spirulina oscillariorides* Turpin, *Arthrospira major* (Kütz.) Crow **(Pl.1, Fig. 10)**

Trichomes pale to bright blue green, 1.2-2 µm wide, regularly screw like coiled, coils left handed, distance between spirals 4-4.5 µm.

Odisha: Huluhula, Ganjam. Epipsammic mat, 20.04.2008, V.N. – 1488.

24. **Spirulina nodosa** Schiller; Komárek and Anagnostidis 2005, p. 140, fig. 163 **(Pl. 5, fig.19)**

Thallus bluish green, filamentous, trichome without sheath, loosely coiled, coiling left handed, indistinct cell wall, cells 16-18 µm long, 3.5 µm broad.

Sikkim: Lachung. Blackish to grey epilithic biofilm, 14.06.2010, V.N. – 2538.

25. **Spirulina subsalsa** Örsted ex Gom.; Komárek and Anagnostidis 2005, p. 150, fig. 176 **(Pl.1, Fig. 11)**

Trichome blue green, regularly densely screw like coiled, coiling dextral, constriction not visible, coils tightly joined to another, parallel arranged, cells 2.3 µm wide, trichome is 4.5 µm wide.

Odisha: Huluhula, Ganjam. Epipsammic mat, 20.04.2008, V.N. – 1488.

26. **Homoeothrix endophytica** (Lemmerm.) Lemmerm. ; Komárek & Anagnostidis 2005, p. 252, fig. 1005; Synonym – *Calothrix endophytica* Lemmerm. **(Pl. 5, Fig. 16)**

Thallus bluish green, filamentous, 7.5 µm broad, sheathed, sheath brownish, trichome broader at base, gradually narrowed to pointed apex, cells broader than long at base, 2.5-3.5 µm long, 6.25 µm broad, heterocyst absent.

Sikkim: Zero point, North District. Epilithic biofilm on wet rock, 16.06.2010. V.N.– 2558.

27. **Homoeothrix janthiana** (Born. & Flah.) Starmach; Komárek & Anagnostidis 2005, p. 263, fig. 352 **(Pl. 5, Fig.14)**

Thallus bluish green, always in a tuft, trichomes straight to bent at the apices, sheath thick, cell wall not constricted, filament broader at the base, gradually attenuated towards apices, cells 2-4 µm long, 2 µm wide, cell content homogenous.

Sikkim: Chungthang. Epilithic biofilm, 15.06.2010, V.N. – 2555.

28. **Homoeothrix juliana** (Born. & Flah.) Kirchner; Komárek and Anagnostidis 2005, p. 652, fig. 1010; Basionym – *Lyngbya juliana* Meneghini; Synonym - *Lyngbya juliana* Meneghini, *Leibleinia juliana* (Meneghini) Kütz., *Phormidium julianum* (Meneghini) Rabenhorst, *Calothrix juliana* (Meneghini) Born. & Flah. **(Pl.1, Fig. 12)**

Filament solitary, erect, unbranched, slightly curved, bulbous widened at the base, 10-12.6 µm broad; sheath thin, attached to trichome, slightly lamellated at the lower part, not constricted; cross walls indistinct, cell content granulated, trichome gradually tapering towards end.

Odisha: Phurlijharan, Kalahandi (20°C, pH-6.2). Green slimy epilithic biofilm, 23.03.2009, V.N.- 2377.

29. ***Homoeothrix poljanskii** Muzafarov; Komárek & Anagnostidis 2005, p. 269, fig. 359; Synonym- *Homoeothrix schizothrichoides* Muzafarov **(Pl.1, Fig. 8)**

Thallus brownish to grey green, filamentous, false branched, aggregated into a tuft, sheathed, sheath not lamellated, colorless, filament 7-10 µm wide, not constricted at cross walls, trichome attenuated towards end into hairs.

Odisha: Phurlijharan, Kalahandi (20°C, pH- 6.2). Blackish brown epilithic biofilm, 23.03.2009, V.N. - 2383.

30. ***Homoeothrix varians** Geitler; Komárek and Anagnostidis 2005, p. 265, fig. 353 **(Pl.5, Fig. 15)**

Filaments in cluster, trichome unbranched, erect, thin sheathed, cells discoid, as long as broad, 2.5 µm broad.

West Bengal: Chitrey, Kalimpong (29°C; pH - 6.8). Blue green epilithic biofilm, 08.09.2008, V.N. – 1753. Sikkim: Pastanga (20°C, pH - 6.7). Epilithic biofilm, 14.09.2008, V. N. – 1800. Date of collection - 14.09.2008; Odisha: Sitakund, Mayurbhanj. Epilithic biofilm, 06.10.2008, V. N. – 2033.

31. ***Trichocoleus erectiusculus** (Starmach) Anagnostidis & Komárek in Anagnostidis Komárek and Anagnostidis 2005, p. 318, fig. 427; Basionym - *Microcoleus erectiusculus* Starmach**;** Synonym - *Microcoleus erectiusculus* Starmach **(Pl.1, Fig. 13)**

Filaments with several trichome, not divaricated, flexuous, sheath very thin, colorless, trichome bluish green, fasciculate, slightly constricted at cross walls, not attenuated, cells without granules, 1.25-1.8 µm broad and 5-6 µm long , apical cell slightly conical and bluntly pointed.

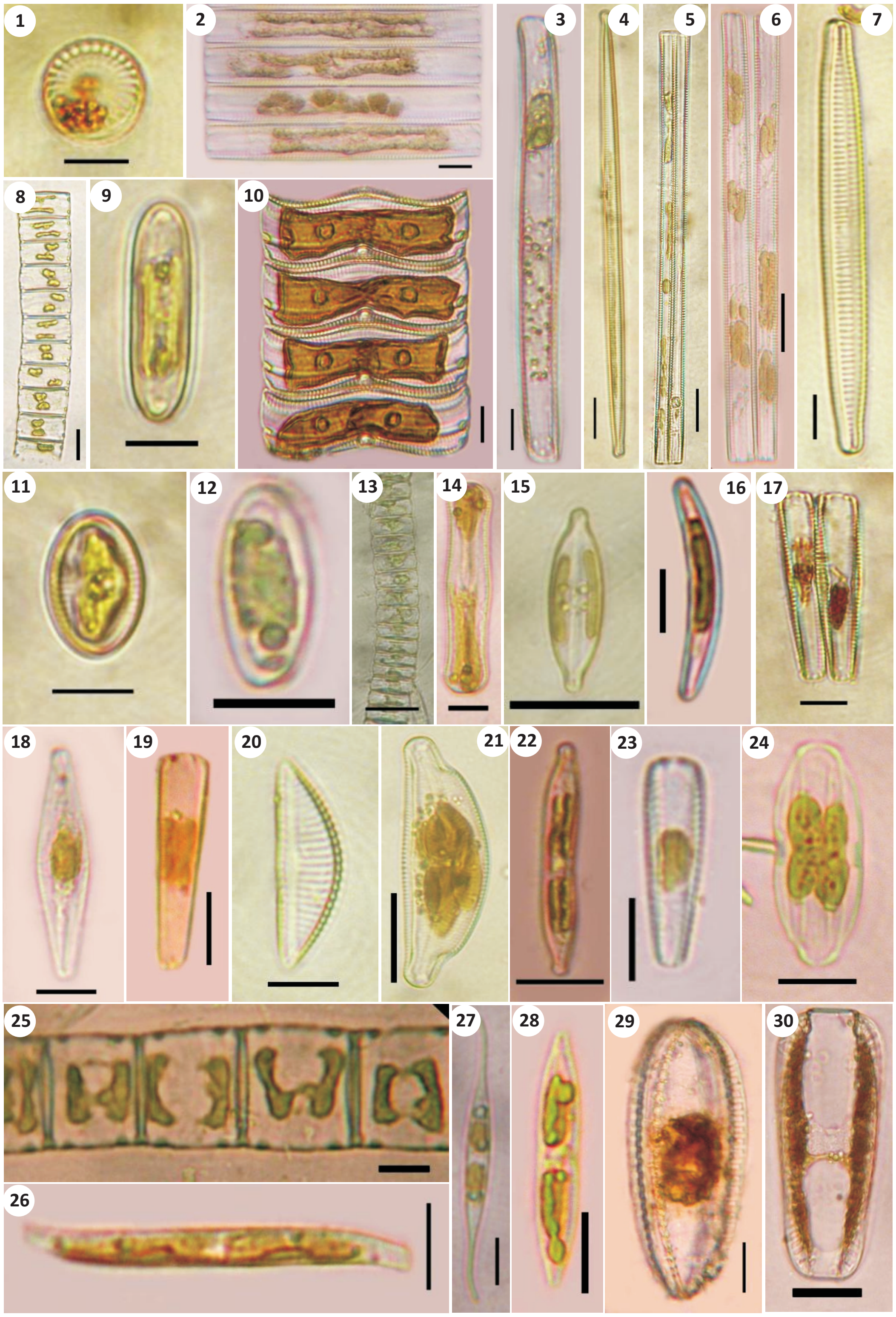

Plate-4 (Fig.1-30): 1. *Cyclotella meneghiniana;* **2.** *Fragillaria virescence;* **3.** *Synedra tergestina;* **4.** *Synedra ulna;* **5.** *Synedra ulna* var. *aequalis;* **6.** *Synedra ulna* var. *amphirhynchus;* **7.** *Synedra ulna* var. *oxyrhynchus;* **8.** *Diatoma pectinale;* **9.** *Achnanthes coarctata* var. *parallela;* **10.** *Achnanthes inflata;* **11.** *Cocconeis pediculus;* **12.** *Diploneis pullea;* **13.** *Diadesmis confervacea;* **14.** *Pinnularia acrosphaeria f. undulata;* **15.** *Navicula exigua;* **16.** *Navicula lunata;* **17.** *Gomphonema micropus;* **18.** *Gomphonema montanum* var. *genuinum;* **19.** *Gomphonema parvulum* var. *micropus;* **20.** *Cymbella affinis;* **21.** *Cymbella tumida;* **22.** *Eunotia amphioxys;* **23.** *Licmophora abreviata;* **24.** *Amphora veneta;* **25.** *Himantidium minus;* **26.** *Nitzschia sigmoidea;* **27.** *Nitzschia closterium;* **28.** *Nitzschia vasnii;* **29.** *Surirella euglepta;* **30.** *Surirella splendida* (Scale bar: Figs. 1-30=10µm.)

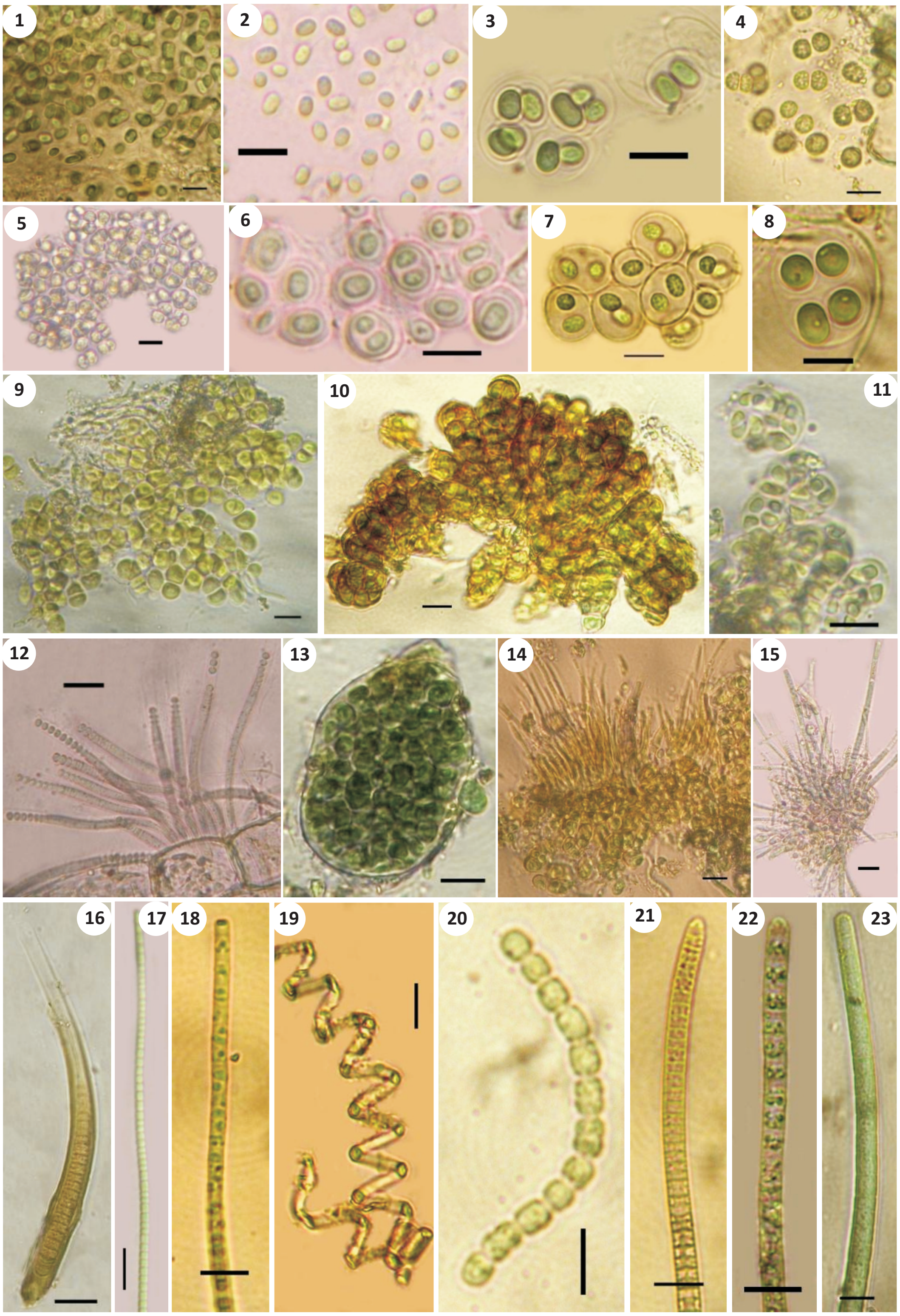

Plate-5 (Fig. 1-23): 1. *Aphanothece microscopica;* **2.** *Aphanothece saxicola;* **3.** *Gloeothece rupestris;* **4.** *Synechocystis pevalekii;* **5.** *Gloeocapsa crepidinum;* **6.** *Gloeocapsa gelatinosa;* **7.** *Gloeocapsa kützingiana;* **8.** *Gloeocapsa punctata;* **9.** *Gloeocapsopsis crepidinum;* **10.** *Gloeocapsopsis magma;* **11.** *Cyanosarcina spectabilis;* **12.** *Chamaesiphon confervicola* var. *elongatus;* **13.** *Chroococcidiopsis kashayi;* **14.** *Homoeothrix janthiana;* **15.** *Homoeothrix varians;* **16.** *Homoeothrix endophytica;* **17.** *Pseudanabaena limnetica;* **18.** *Geitlerinema lemmermanii;* **19.** *Spirulina nodosa;* **20.** *Komvophoron constrictum;* **21.** *Planktothrix suspensa;* **22.** *Tychonema rhodonema;* **23.** *Phormidium chlorinum.*

(Scale: Figs. 1-11 & 13-23 =10µm; Figs. 12= 20µm.)

Odisha: Narayani, Khurda (29°C, pH- 6.8). Epilithic biofilm, 02.10.2008, V.N. - 1875.

32. ***Komvophoron constrictum** (Szafer) Anagnostidis & Komárek; Komárek & Anagnostidis, 2005, p. 333, fig. 462; Basionym – *Oscillatoria constricta* Szafer **(Pl. 5, Fig.20)**

Trichomes slightly bent, deeply constricted at the cross walls, 4.2 µm wide, cells barrel shaped with rounded ends, 3.5 – 5 µm long, cell content with few small black granules, apical cell rounded.

Nagaland: Pherem, Planktonic, 18.02.2011, V.N.– 3027.

33. **Planktothrix suspensa** (Pringsheim) Anagnostidis *&* Komárek; Komárek & Anagnostidis 2005, p. 358, fig. 498, 507; Synonym – *Oscillatoria agardhii* var. *suspensa* Pringsheim **(Pl. 5, Fig. 21)**

Thallus bluish green, filamentous, solitary, non heterocystous, straight or slightly bent, not constricted, attenuated at the apex, cells broader than long, cells 3 µm long, 4.5 µm broad, air space present, thyllakoid reticulate.

Sikkim: Lachung. Blackish to grey epilithic biofilm, 14.06.2010, V.N. – 2533.

34. **Tychonema rhodonema** (Skuja) Anagnostidis & Komárek; Komárek & Anagnostidis 2005, p. 375, fig. 528; Synonym – *Oscillatoria rhodonema* Skuja **(Pl. 5,Fig. 22)**

Trichome solitary, not sheathed, not constricted, non heterocystous, cell slight longer than broad, granulated at both side of the cross wall, cells 3.6-4 µm long, 4.5 µm broad.

Sikkim: Chunthang. Blackish to grey epilithic biofilm, 15.06.2010, V.N. – 2553.

35. **Geitlerinema lemmermanii** (Woloszyńska) Anagnostidis; Komárek & Anagnostidis 2005, p. 136, fig. 149; Basionym – *Oscillatoria lemmermanii* Woloszyńska; Synonym – *Jaaginema lemmermanii* (Woloszyńska) Anagnostidis & Komárek **(Pl. 5, Fig. 18)**

Trichomes pale blue green, solitary, slightly bent, 3 µm wide, not constricted at the granulated crosswalls, gradually attenuated at the ends and curved, cells 9 -10 µm long, apical cell slightly narrowed, without calyptra.

Sikkim: Lachung. Blackish to grey epilithic biofilm, 14.06.2010, V.N. – 2535.

36. **Phormidium autumnale** (C. Agardh) Trevisan ex Gom.; Komárek & Anagnostidis 2005, p. 473, fig. 707; Basionym – *Oscillatoria autumnalis* C. Agardh; Synonym – *Oscillatoria autumnalis* (Agardh) Gaillon; *Phormidium autumnale* (Agardh) Trevissan; *Microcoleus autumnalis* (Agardh) Rabenhorst; *Phormidium autumnale* (Agardh) Gom.; *Phormidium vulgare* Kütz.; *Phormidium membranaceum* Kütz.; *Microcoleus membranaceus* Kütz. ex Rabenhorst; *Lyngbya membranacea* (Kütz.) Thur.; *Phormidium subsalasum* Gom. **(Pl.1, Fig. 14)**

Thallus bluish green, filaments straight, solitary, thin sheathed, 3.5 µm wide, crosswalls not constricted, slightly granulated, cells slightly longer than broad, 3-4 µm long, apical cell elongate, truncated, slightly produced rounded calyptra.

Odisha: Narayani, Khurda (29°C, pH- 6.8). Epipelic, 17.05.2008, V. N. - 1499. Odisha: Nirmalajhara, Ganjam. Slimy epilithic biofilms, 17.05.2008, V.N. – 1506; Odisha: Devkund, Mayurbhanj. Epilithic in stream, 06.01.2011, V.N.– 4518.

37. **Phormidium chlorinum** (Kütz. ex Gom.) Anagnostidis; Komárek & Anagnostidis 2005, p. 436, fig. 634; Synonym – *Oscillatoria chlorina* Kütz. ex Gom. **(Pl. 5, Fig. 23)**

Filament straight, yellowish green, 5.8 µm in diameter, cross walls slightly constricted and granulated, cells almost isodiametric, 2.5 – 5 µm long, apical cell rounded.

Arunachal Pradesh: Sangey. Epilithic, 29.10.2010, V.N.– 2686; Sikkim: Chungthang. Epilithic biofilm, 15.06.2010, V.N. – 2556.

38. **Phormidium favosum** Gom. ex Gom.; Komárek and Anagnostidis 2005, p. 473, fig. 708- a, d; Basionym: *Oscillatoria favosa* Bory; Synonym: *Oscillatoria favosa* Bory **(Pl. 6, Fig. 1)**

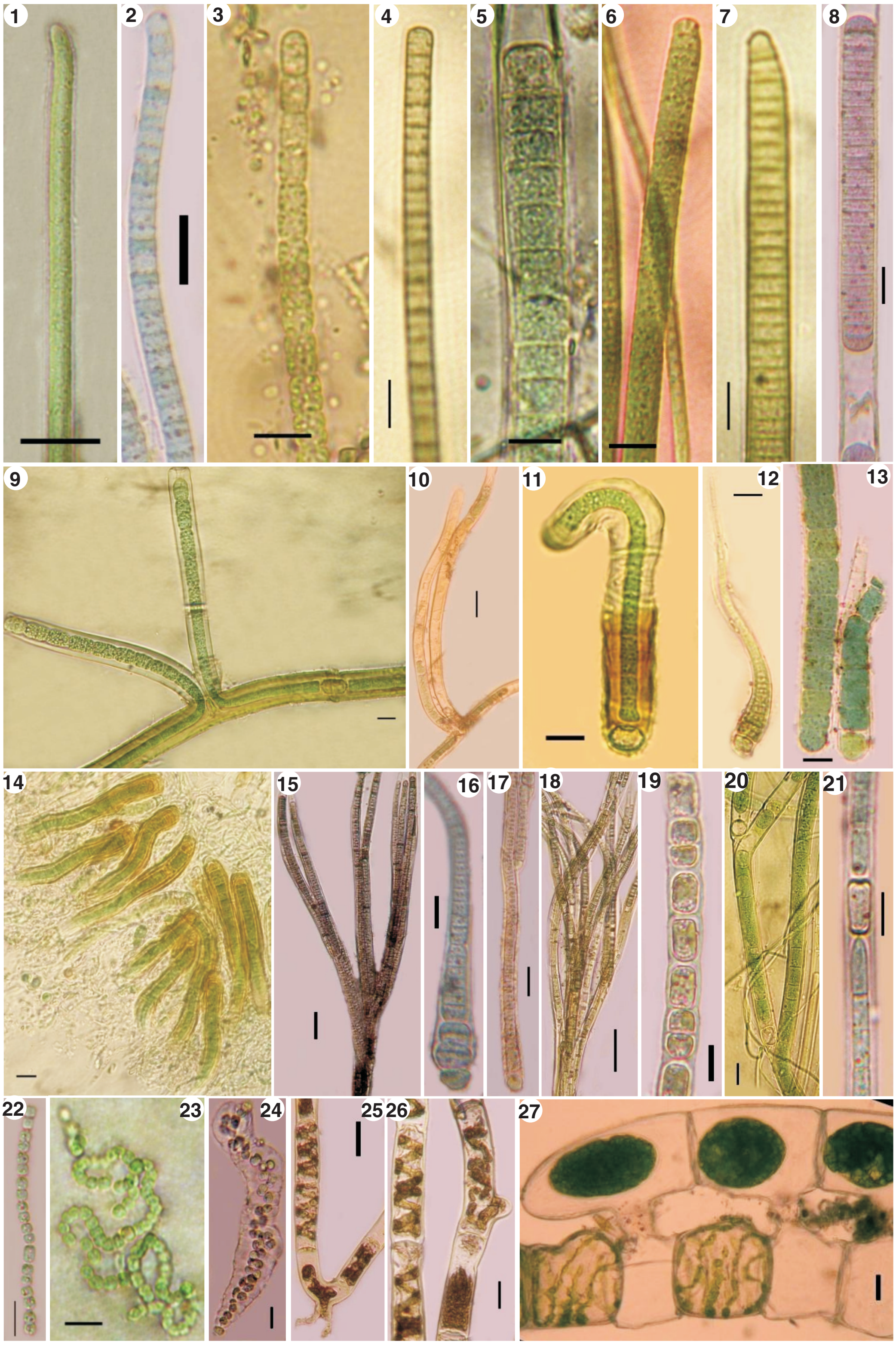

Plate-6 (Fig. 1-27): 1. *Phormidium favosum;* **2.** *Phormidium granulatum;* **3.** *Phormidium hamelii;* **4.** *Phormidium numidicum;* **5.** *Phormidium retzii;* **6.** *Oscillatoria princeps;* **7.** *Oscillatoria yamadae;* **8.** *Lyngbya truncicola;* **9.** *Scytonema guyanense;* **10.** *Scytonema pseudohofmanni;* **11.** *Calothrix fusca;* **12.** *Calothrix geitonos;* **13.** *Calothrix marchica* var. *crassa;* **14.** *Calothrix parietina;* **15.** *Dichothrix fusca;* **16.** *Dichothrix ledereri;* **17.** *Dichothrix orsiniana;* **18.** *Dichothrix spiralis;* **19.** *Microchaete uberrima;* **20.** *Tolypothrix distorta;* **21.** *Aulosira fertilissima* var. *tenuis;* **22.** *Nostoc muscorum;* **23.** *Nostoc spongaeforme;* **24.** *Nostoc commune;* **25.** *Spirogyra affinis;* **26.** *Spirogyra esthonica;* **27.** *Spirogyra hydrodictya*

(Scale: Figs. 1-9, 11 - 17 & 19-24=10µm; Figs. 10, 18, 25 & 26 = 20µm; Fig. 27 = 30µm.)

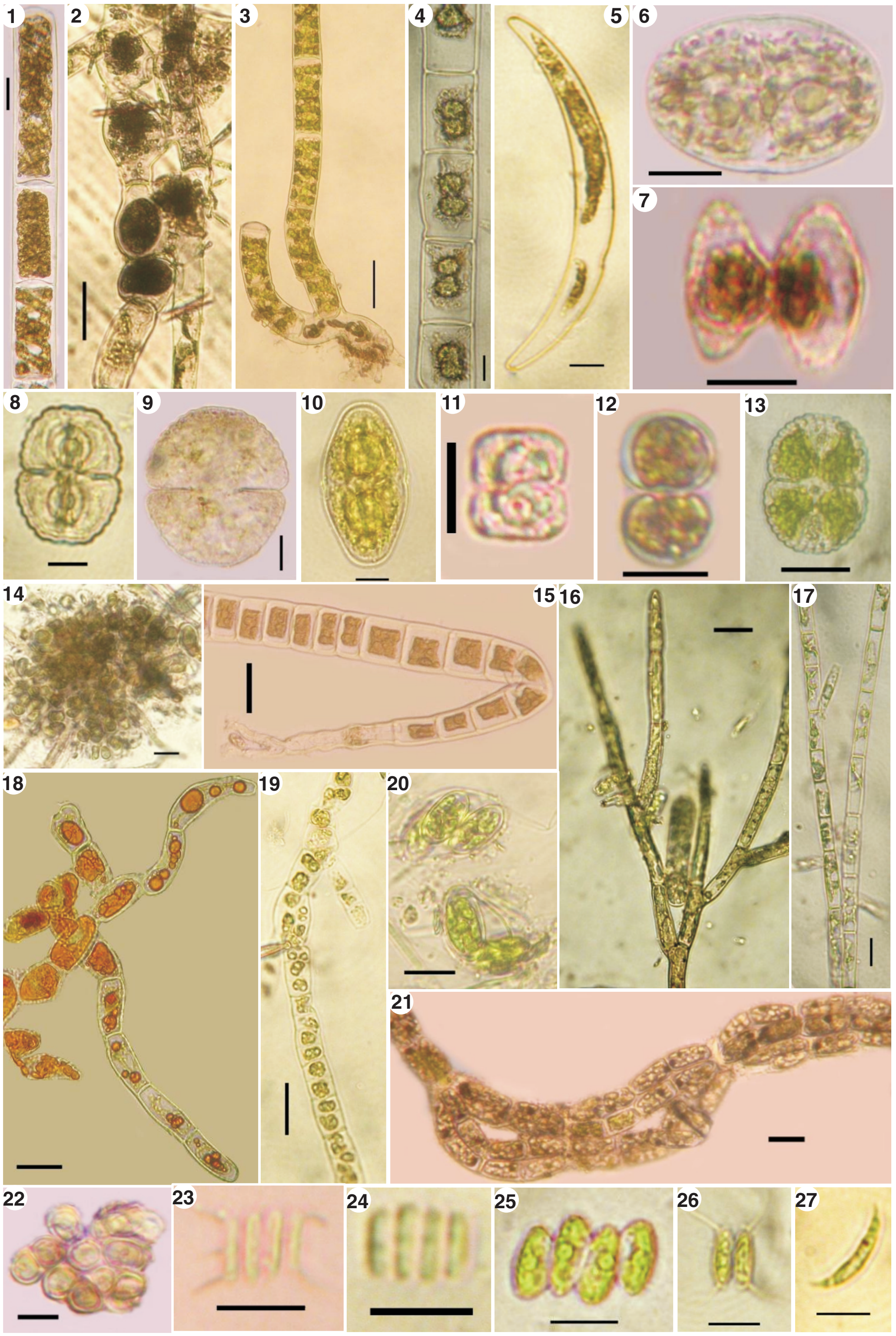

Plate-7 (Fig. 1-27): 1. *Spirogyra maravillosa;* **2.** *Spirogyra parvula;* **3.** *Spirogyra rhizopus;* **4.** *Zygnema pseudopunctinatum;* **5.** *Closterium moniliferum;* **6.** *Cylindrocystis ovalis;* **7.** *Staurastrum bieneanum* var. *ellipticum;* **8.** *Cosmarium awadhense;* **9.** *Cosmarium formosulum;* **10.** *Cosmarium microsphintum* f. *parvula;* **11.** *Cosmarium praecisum;* **12.** *Cosmarium quadrifarium* var. *oblonga;* **13.** *Cosmarium radiosum;* **14.** *Coleochaete scutata;* **15.** *Ulothrix tenuissima;* **16.** *Stigeoclonium curvirostrum;* **17.** *Stigeoclonium longipilum;* **18.** *Epibolium polyspermum;* **19.** *Radiofilum transversalis;* **20.** *Glaucocystis simplex;* **21.** *Ecballocystopsis dichotomus;* **22.** *Botryococcus protuberans;* **23.** *Desmodesmus spinosus;* **24.** *Scenedesmus bijugatus;* **25.** *Scenedesmus ecornis* var. *ecornis;* **26.** *Scenedesmus pseudopoliensis;* **27.** *Monoraphidium fontinale*

(Scale bar: Figs. 4-8, 10-17, 19-20 & 23-27= 10µm; Figs. 1, 9, 18, 21 & 22= 20µm; Fig. 2, 3 = 50µm.)

Thallus blue green, sheath absent, not constricted, cross walls coarsely granulated, slightly attenuated to the end, capitate; cells slightly longer than broad, 5 µm broad and 3.75 µm long, apical cell capitate with obtuse conical, nearly hemispherical calyptra.

West Bengal: On the way to Tiger hill, Darjeeling. Epilithic green, slimy biofilm; 10.09.2008, V.N.– 1763; West Bengal: Rock garden, Darjeeling (20°C, pH - 6.8). Strongly attached epilithic biofilms, 10.09.2008, V.N. – 1775; Sikkim: Kyongnosola. Bluish green patch attached to rock surface; 12.09.2008, V.N.– 1789.

39. ***Phormidium granulatum** (Gardner) Anagnostidis; Komárek and Anagnostidis 2005, p. 439, fig. 640; Basionym – *Oscillatoria granulata* Gardner; Synonym - *Oscillatoria granulata* Gardner, *Tychonema granulatum* (Gardner) Anagnostidis & Komárek **(Pl. 6, Fig. 2)**

Trichome solitary, slightly curved towards apex, cross wall not constricted, cells ± isodimetric or broader than long, 4.5 µm broad, 3.6 µm long, distinctly granulated cross walls, rounded cell apices, not attenuated, not capitate.

Odisha: Narayani, Khurda (29°C, pH- 6.8). Epipelic, 17.05.2008, V. N.- 1499; Sikkim: Hanumantok, Gantok (18°C, pH - 6.8). Epilithic biofilm, 12. 09. 2008, V.N. – 1780.

40. **Phormidium hamelii** (Fremy) Anagnostidis & Komárek; Komárek & Anagnostidis 2005, p. 450, fig. 659; Synonym- *Oscillatoria hameii* Fremy **(Pl. 6, Fig. 3)**

Thallus bluish green, filamentous, trichome solitary, straight, constricted at cross walls, cell content granulated, apical cell widely rounded, cells longer than broad, cell 5 µm broad, 7.5 µm long.

Sikkim: Lachung. Blackish to grey epilithic biofilm, 14.06.2010, V. N. – 2532.

41. ***Phormidium koprophilum** (Skuja) Anagnostidis; Komárek and Anagnostidis 2005, P.447, Fig. 657 **(Pl.1, Fig. 15)**

Thallus bluish green, trichome solitary, straight to slightly bent, bent at the apex, slightly constricted at the crosswalls, not capitate, cells broader than long, 6 µm broad, 3.3-4.4 µm long, cell content granulated, apical cell broadly rounded

Odisha: Huluhula, Ganjam. Epilithic biofilm, 17.05.2008, V.N. – 1518; Odisha: Devkund, Mayurbhanj. Epilithic in stream, 06.01.2011, V.N. – 4518.

42. ***Phormidium numidicum** (Gom. sensu Welsh) Angnostidis; Komárek & Anagnostidis 2005, p. 436, fig. 632; Basionym – *Oscillatoria numidica* Gom. **(Pl. 6, Fig. 4)**

Thallus bluish green, trichome 4 - 5 µm broad, slightly constricted at the cross walls, not attenuated towards the tip, cells 3.7 - 4 µm long, apical cell rounded.

Arunachal Pradesh: Jaswant garh. Epilithic, 29.10.2010, V.N.– 2696.

43. ***Phormidium puteale** (Montagne ex Gom.) Anagnostidis & Komárek; Komárek and Anagnostidis 2005, p. 456, fig. 665 **(Pl.1, Fig. 16)**

Thallus bluish to grayish green, filaments elongated, straight or slightly bent, sheath thick 2.5 µm, trichome slightly constricted, cells broader than long, 6-8 µm long and 12 µm broad.

Odisha: Harishankar, Balangir (pH - 6.7). Bluish green epilithic biofilm, 27.07.2008, V.N.– 1652; Odisha: Pradhanpat, Deogarh. Epilithic on rock surface; 28.07.2008, V.N.– 1653; Place of collection – Nrushinghanath, Baragarh, Odisha; Habitat – epilithic in the stream; V.N.– 2652; Date of collection - 18.09.2010.

44. **Phormidium retzii** (C. Agardh) Gom. ex Gom.; Komárek & Anagnostidis 2005, p. 454, fig. 666; Basionym– *Oscillatoria retzii* Agardh; Synonym - *Oscillatoria retzii* Agardh, *Conferva retzii* (Agardh) Sommerfelt, *Phormidium retzii* (Agardh) Kütz., *Microcoleus retzii* (Agardh) Rabenhorst, *Lyngbya retzii* (Agardh) Hansg. **(Pl.6, Fig. 5)**

Thallus bright blue green, filaments straight, sheath diffluent, trichome bright to dark blue green, 5.7 µm broad, mostly unconstricted, slightly constricted at the ungranulated crosswalls, not attenuated at the ends, cells isodiametric or slightly shorter or longer than wide, 2.8-3.8 μm long, apical cell attenuated, obtuse-rounded or truncate, with thin outer cell wall, without calyptra

Sikkim: Kyongnosola (14°C, pH – 6). Bluish green patch attached to rock surface; 12.09.2008, V.N.– 1789.

45. ***Phormidium terebriforme** (Ag. ex Gom.) Anagnostidis & Komárek; Komárek and Anagnostidis 2005, P.412, Fig. 584 **(Pl.1, Fig. 17)**

Thallus bluish green, trichome solitary, straight, bent at the apex, attenuated, slightly constricted at the crosswalls with acutely apical cell, not capitate, cells broader than long, 5.6 μm broad, 2.8 μm long, cell content finely granulated.

Odisha: Huluhula, Ganjam. Epilithic biofilm, 17.05.2008, V.N. – 1518; Odisha: Harishankar, Balangir (pH - 6.7). Bluish green epilithic mass under flowing water, 27.07.2008, V.N.– 1647.

46. **Phormidium tergestinum** (Kütz.) Anagnostidis & Komárek; Komárek & Anagnostidis 2005, p. 451, fig. 662; Basionym – *Oscillatoria tergestina* Kütz.; Synonym - *Oscillatoria tergestina* Kütz., *Lyngbya phormidium* Kütz., *Symploca phormidium* (Kütz.) Thur., *Oscillatoria tenuis* var. tergestina (Kütz.) Rabenhorst ex Gomont, *Lyngbya phormidium* Kütz. ex Gom., *Oscillatoria tenuis* f. *tergestina* (Kütz.) Elenkin **(Pl.1, Fig. 18)**

Trichomes thin, olive green, usually straight, sometimes slightly curved, 4-4.5 μm wide, not constricted at the crosswalls, cells isodiametric and shorter, 3.3 μm in length, contents homogenous, sometimes with large granules, apical cell rounded.

Odisha: Huluhula, Ganjam. Epipsammic mat, 20.04.2008, V.N. – 1488; Odisha: Ghagra, Keonjhar. Brownish biofilm, 25.11.2008, V.N.- 2070.

47. **Oscillatoria acuta** Brühl et Biswas, Orth. Mut. Geitler; Desikachary 1959, p. 240, pl. 39, fig. 5, 8 **(Pl.1, Fig. 19)**

Trichome solitary, not constricted at the crosswalls, 4.48 μm thick, narrow or acuminate towards the sub obtuse, non capitate, non calyptrate apex, straight but more often abruptly bent aside, cells 4.7 μm long, contents bluish green, finely granular.

Odisha: Narayani, Khurda (29°C, pH- 6.8). Epilithic biofilm, 02.10.2008, V.N.- 1866; Odisha: Nirmalajhara, Ganjam. Slimy epilithic biofilms, 17.05.2008, V.N.– 1506.

48. **Oscillatoria agardhii** Gom.; Desikachary 1959, P.235 **(Pl.1, Fig. 20)**

Thallus bluish green, trichome solitary, bent towards apices, cells broader than long, 5.6μm broad, and 3.2 μm long, trichome producing hormogonia and necridia, cell content finely granulated, cell apices broadly rounded, not capitate, cross wall not constricted.

Odisha: Barunei, Khurda. V.N.- Epilithic biofilm in the stream, 17.05.2008, 1492; Odisha: Narayani, Khurda (29°C, pH- 6.8). Epilithic biofilm, 02.10.2008, V.N.- 1866; Odisha: Panchalingeswar. Epilithic biofilms, 02.10.2008, V.N.– 4613.

49. **Oscillatoria limosa** C. Agardh ex Gom.; Komárek & Anagnostidis 2005, p. 593, fig. 886 **(Pl.1, Fig. 21)**

Thallus blackish blue green, trichomes bright green, straight, slightly bent, sheath absent, not constricted at the crosswalls, 13.7 μm wide, cells shorter than broad, 2.5 μm long, cell content granular, apical cell flatly rounded, without calyptra.

Odisha: Devkund, Mayurbhanj. Epilithic in stream, 06.01.2011, V.N.– 4519.

50. **Oscillatoria princeps** Vaucher ex Gom.; Desikachary 1959, p. 210, pl. 37, fig. 10, 11**;** Synonym- *Oscillatoria princeps* Vaucher, *Trichophorus princeps* (Vaucher) Desvaux, *Oscillatoria princeps* (Vaucher) Gaillon, *Lyngbya princeps* (Vaucher) Hansg.) **(Pl. 6, Fig. 6)**

Thallus blue green, filament straight, not constricted at the cross walls, 8.5 µm broad, slightly or briefly attenuated at the apices and bent, cells 3-4 µm long, end cell flatly rounded, slightly capitate.

Arunachal Pradesh: Sairang. Floating green mats; 23.03.2008, V.N.- 1427; Nagaland: Pherem, Planktonic, 18.02.2011, V.N.– 3028.

51. ***Oscillatoria yamadae** N.D. Kamat; Komárek & Anagnostidis 2005, p. 602, fig. 910 **(Pl. 6, Fig.7)**

Trichome long, straight, 8 - 9 µm broad, cells 2.5 – 4.4 µm long, cross wall slightly granulated, but not constricted, filaments slightly attenuated towards the end, apical cell capitate, without calyptra.

Arunachal Pradesh: Doimukh. Epilithic; 03.11.2010, V.N.- 2766; Nagaland: Pherem, Planktonic, 18.02.2011, V.N.– 3028.

52. **Lyngbya hieronymusii** Lemmerm.; Komárek & Anagnostidis 2005, p. 614, fig. 934 **(Pl.1, Fig. 22)**

Solitary, free floating filaments, straight, 10 µm wide, sheaths firm, colorless, trichome blue green, 5 - 6 µm wide, not constricted at the cross walls, with aerotopes, not attenuated at the ends, cells 2 - 2.5 µm long, apical cells widely round.

Odisha: Harishankar, Balangir (pH - 6.7). Bluish green epilithic mass under flowing water, 27.07.2008, V.N. – 1650.

53. **Lyngbya majuscula** Harvey ex Gom.; Komárek & Anagnostidis 2005, p. 623, fig. 950; Basionym – *Conferva majuscula* Dilwyn; Synonym - *Conferva majuscula* Dilwyn, *Oscillatoria majuscula* (Dilwyn) Dilwyn, *Elisa majuscula* (Dilwyn) Gray, *Lyngbya major* var. *kerquelenensis* Reinsch, *Lyngbya majuscula* var. *kerquelenensis* Reinsch ex Forti **(Pl.1, Fig. 23)**

Filament dark bluish-green, sheathed, sheath colorless, lamellated, sometimes without lamination; trichome cylindrical, not constricted, ungranulated cross walls, not attenuated; cells discoid, 32-40 µm broad , 3-6 µm long, broader than long, apical cell rounded.

Odisha: Huluhula, Ganjam. Epilithic biofilm, 17.05.2008, V.N. – 1520; Odisha: Pradhanpat, Deogarh (pH-7.2). Epilithic on rock surface; 28.07.2008, V.N.– 1653; Odisha: Ghagra, Keonjhar. Filamentous mat, 25.11.2008, V.N.- 2076.

54. **Lyngbya sordia** (Zanard.) Gom.; Desikachary 1959, P. 285, Pl. 52, Fig.1 **(Pl.1, Fig. 24)**

Thallus brownish green, filamentous, unbranched, sheath lamellated, 4.5 µm wide, trichome constricted at cross walls, apical cells wide rounded, cell content granulated, cells broader than long, 4.2 µm long, 11.2 µm broad.

Odisha: Pradhanpat, Deogarh (pH- 7.2). Epilithic on rock surface; 28.07.2008, V.N.– 1653.

55. ***Lyngbya splendens** Gardner; Komárek and Anagnostidis 2005, p. 630, fig. 965 **(Pl.1, Fig. 25)**

Filament bluish-green, sheathed, 16.5µm broad, sheath colorless, not lamellated; trichome not constricted at cross walls, apical cell obtuse rounded, cell broader than long, 12 µm broad, 5.5-7.7µm long, not granulated.

Odisha: Sitakund, Mayurbhanj. Epilithic biofilm, 06.10.2008, V.N. – 2033.

56. **Lyngbya truncicola** Ghose; Komárek and Anagnostidis 2005, p. 618, fig. 937 **(Pl. 6, Fig. 8)**

Thallus dirty blue green, filament straight, sheath not lamillated, trichomes cylindrical, blue green, 10-11 µm wide, not constricted at the ungranulated cross walls, not attenuated, cells broader than long, 3-5.8 µm long, 14 µm broad, apical cell rounded, without calyptra.

West Bengal: Rock garden, Darjeeling (20°C, pH - 6.8). Strongly attached epilithic biofilms, 10.09.2008, V.N. – 1777; Sikkim: Pastanga (20°C, pH - 6.7). Epilithic on moist rocks, 14.09.2008, V.N. – 1804.

57. **Scytonema guyanense** (Mont.)Born et Flah.; Desikachary 1959, P. 469, Pl.92, fig.5 **(Pl. 6, Fig. 9)**

Thallus bluish green, filamentous, sheathed,15-17 µm broad, pseudo branched, heterocystous, sheath

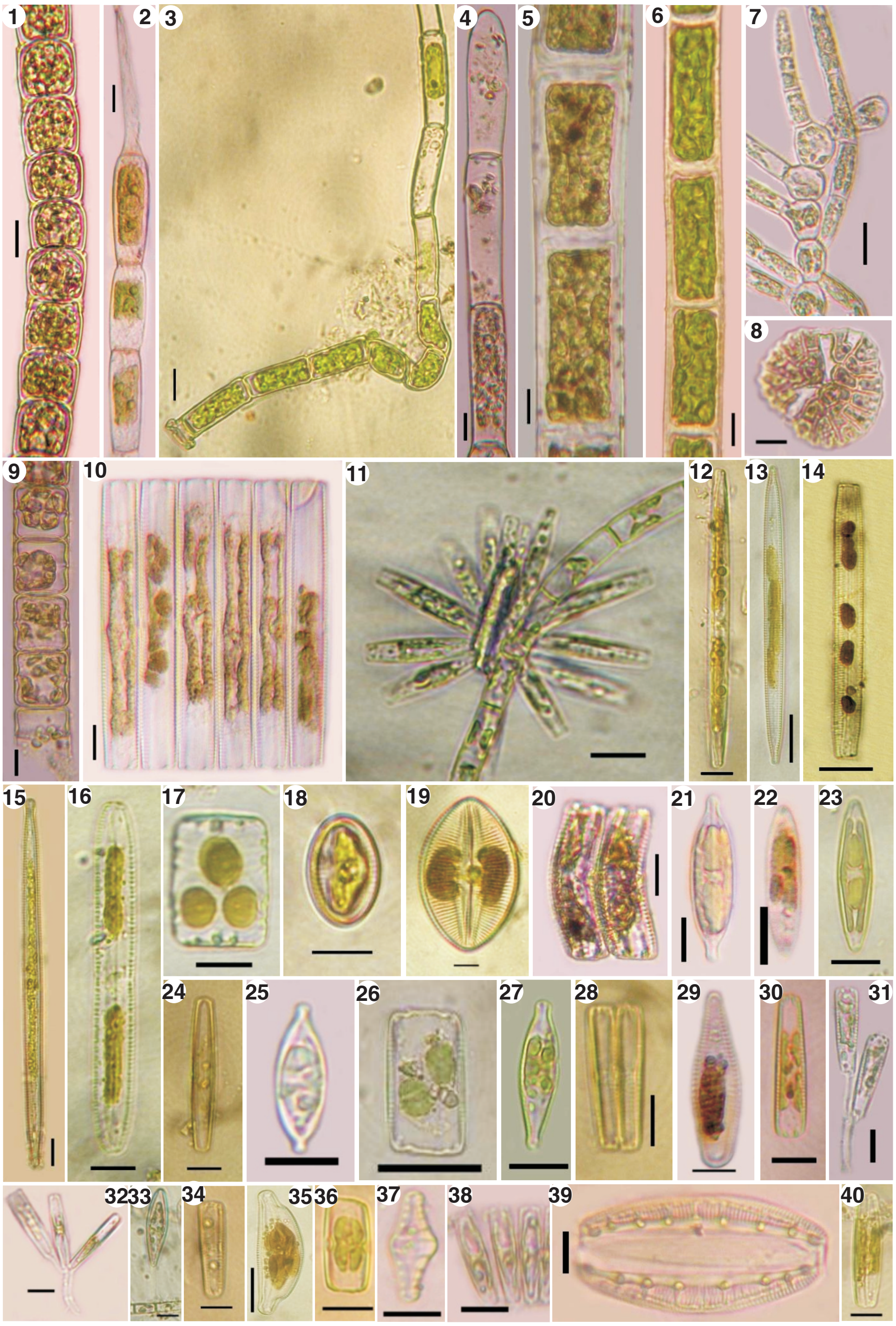

Plate-8 (Fig. 1-40): 1. *Oedogonium chaetophorum* var. *chaetophorum;* **2.** *Oedogonium pisanum;* **3.** *Oedogonium randhawae;* **4.** *Oedogonium wyliei;* **5.** *Microspora amoena;* **6.** *Microspora indica;* **7.** *Leptosira mediciana;* **8.** *Phycopeltis epiphyton;* **9.** *Melosira varians* var. *aequalis;* **10.** *Fragillaria virescens;* **11.** *Synedra affinis;* **12.** *Synedra gallionii;* **13.** *Synedra ulna;* **14.** *Synedra ulna* var. *aequalis;* **15.** *Synedra ulna* var. *amphirhynchus;* **16.** *Synedra ulna* var. *oxyrhynchus;* **17.** *Diatoma mesodon* f. *quadratum;* **18.** *Cocconeis pediculus;* **19.** *Dploneis subovalis;* **20.** *Acnanthes subsessilis;* **21.** *Stauroneis birostris;* **22.** *Navicula borealis;* **23.** *Navicula gracilis;* **24.** *Navicula lanceolata;* **25.** *Navicula sphaerophora;* **26.** *Navicula viridis;* **27.** *Navicula viridula;* **28.** *Gomphonema abbreviatum;* **29.** *Gomphonema constrictum* var. *capitatum;* **30.** *Gomphonema elegans* var. *robusta;* **31.** *Gomphonema exiguum;* **32.** *Gomphonema minutissimum;* **33.** *Gomphonema olivaceum;* **34.** *Gomphonema telegraphicum;* **35.** *Cymbella tumida;* **36.** *Grammatophora undulata;* **37.** *Nitzschia sinuate* var. *tabelaria;* **38.** *Sphenella angustata;* **39.** *Epithemia gibberula* var. *producta;* **40.** *Epithemia turgidula*

(Scale bar: Figs. 1-5 & 7-40 = 10µm; Figs. 6 = 20µm.)

lamellated, heterocyst ellipsoidal, intercalary, cells granulated, longer than broad, trichome constricted, cells 13-17 µm long, 6.5 µm broad.

Sikkim: Lachung. Blackish to grey epilithic biofilm, 14.06.2010, V.N. – 2541.

58. ***Scytonema pseudohofmanni** Bharadwaja; Desikachary 1959, p. 478, pl. 94, fig. 2 **(Pl. 6, Fig. 10)**

Thallus pale green, filament 8.5 µm broad, irregularly curved, pseudobranched, trichome 3 µm broad, heterocyst single, spherical.

Sikkim: Pastanga (20°C, pH - 6.7). Epilithic on moist rocks, 14.09.2008, V.N. – 1804.

59. **Scytonema saleyeriense** var. **indica** Bharadwaja; Desikachary 1959, P. 461, Pl.89, Fig. 6 **(Pl. 2, Fig. 1)**

Thallus yellowish green, filamentous, pseudobranched, sheathed, heterocystous, trichome not constricted, cells broader than long, cells 2 µm long, 6-7 µm broad, sheath 1.5 µm wide, heterocyst ellipsoid.

Odisha: Sitakund, Mayurbhanj. Epilithic biofilm, 06.10.2008, V.N. – 2033; Odisha: Ghagra, Keonjhar. Epixylic, 25.11.2008, V.N.- 2072.

60. **Calothrix geitonos** Skuja; Desikachary 1959, P. 537, Pl. 109, Fig. 6-12 **(Pl. 6, Fig. 12)**

Thallus solitary, filamentous, filament ensheathed up to certain distant, slightly constricted at cross walls, heterocyst basal, hemispherical, 6.4 µm diameter, cell 4.8-6 µm long, 8 µm broad, trichome wider at base gradually narrowed in to an attenuated apex, cell content granular with aerotopes.

Sikkim: Lachung. Blackish to grey epilithic biofilm, 14.06.2010, V.N. – 2535, 2540.

61. **Calothrix fusca** (Kütz.) Born. & Flah.. ; Desikachary 1959, p. 527, Pl. 107, figs. 10; Synonym- *Mastichothrix aeruginea* Kütz. **(Pl. 6, Fig. 11)**

Filament single, unbranched, bent at the middle, 13.75 µm broad, trichome 8.75 µm broad, broader at base gradually attenuated into a narrow tip, cells discoid, heterocyst basal, rounded, sheath colourless, diffluent.

Odisha: Pradhanpat, Deogarh (pH- 7.2). Epilithic on rock surface; 28.07.2008, V.N.– 1657; Odisha: Harishankar, Balangir (pH - 6.7). Bluish green epilithic biofilm, 27.07.2008, V.N.– 1651; Sikkim: Lachung. Blackish to grey epilithic biofilm, 14.06.2010, V.N. – 2531, 2534.

62. **Calothrix marchica** Lemmerm. var. **crassa** C.B. Rao; Desikachary 1959, p. 543, pl. 113, figs. 3, 4 **(Pl. 6, Fig. 13)**

Filament bluish green, trichome straight or slightly bent, solitary, broader at base, gradually attenuated towards apex, constricted cross walls; cells nearly as long as broad, end cell conical, somewhat pointed; heterocyst single, basal, nearly spherical 8 µm broad ; cells 9-10 µm broad , 6-9 µm long .

Mizoram: Phunchawang. Epilithic biofilms, 24.03.2008, V.N.- 1420.

63. **Calothrix parietina** Thur. ex Born. ex Flah.; Desikachary 1959, p. 538, pl. 115, fig. 1; Synonym – *Schizosiphon parietinus* Näg. **(Pl. 6, Fig. 14)**

Thallus bluish green, filamentous, heterocyst basal, sheath traversed along with trichome and became free just before the apex, trichome broader at base, gradually attenuated towards apex, cells broader at base, gradually longer to apex, cell 1.5-5 µm long, basal cell 8 µm broad at base and 6.5 µm at apex, heterocyst 4.5-5 µm in diameter, cell content granular, cells constricted.

Sikkim: Lachung. Blackish to grey epilithic biofilm, 14.06.2010, V.N. – 2533, 2539, 2540.

64. **Dichothrix fusca** F.E. Fritsch; Desikachary 1959, p. 546, pl. 108, figs. 1-3 **(Pl. 6, Fig. 15)**

Thallus blackish blue green, filamentous, pseudobranched, cushion like or pulvinate, filaments sub dichotomously false branched, sheathed, 12 µm broad, cells broader than long, 5 µm long, many trichomes often in a common sheath at the base of the false branches; heterocyst basal, trichome with hormogones, trichome not ended with a hair.

West Bengal: Ganga maya park, Darjeeling. Green filamentous mat; 10.09.2008, V.N.– 1768; Sikkim: Pastanga (20°C, pH - 6.7). Epilithic on moist rocks, 14.09.2008, V.N. – 1801; Odisha: Pradhanpat, Deogarh (pH- 7.2). Epilithic on rock surface; 28.07.2008, V.N.– 1657.

65. ***Dichothrix ledereri** Skacelova; Skácelová 2006, p. 7, fig. 32 D **(Pl. 6, Fig. 16)**

Filaments form clusters, trichome wider at base, gradually narrowed towards apex, trichome constricted at the base of older filament, cells 12 µm broad, 3.32 µm long, cell content homogenous and pale blue green; heterocyst basal, one at base, ellipsoid to rotund form, 10 µm broad and 6.7 µm long.

West Bengal: Rock garden, Darjeeling (20°C, pH - 6.8). Strongly attached epilithic biofilms, 10.09.2008, V.N. – 1772. Sikkim: Ranipool, Gangtok (20°C, pH - 6.7). Green filamentous mat, 14.09.2008, V.N. – 1809.

66. **Dichothrix orsiniana** (Kütz.) Born. & Flah.; Desikachary 1959, p. 548, pl.107, fig. 4 **(Pl. 6, Fig. 17)**

Thallus penicillate, gelatinous, false branched, erect, sheath close to the trichome, thick, brownish, trichome 6.7 µm broad, cells shorter than broad, gradually attenuated, heterocyst basal, sub cylindrical, cells 3.33 µm long.

Odisha: Panchalingeswar. Epilithic biofilms, 02.10.2008, V.N.– 4613; Odisha: Sitakund, Mayurbhanj. Epilithic biofilm, 06.10.2008, V.N. – 2036; West Bengal: Ganga maya park, Darjeeling. Green filamentous mat; 10.09.2008, V.N. – 1766; Sikkim: Pastanga (20°C, pH - 6.7). Epilithic on moist rocks, 14.09.2008, V.N. – 1801.

67. ***Dichothrix spiralis** F.E. Fritsch; Geitler 1925, p. 216, fig. 258 **(Pl. 6, Fig. 18)**

Thallus bluish green, filamentous, pseudo-branched, cushion like (Pulvinate); filaments sub dichotomously false branched, sheathed, 9-12 µm broad, cells 6 µm long, heterocyst basal.

West Bengal: Ganga maya park, Darjeeling. Green filamentous mat; 10.09.2008, V.N.– 1772; Sikkim: Ranipool, Gangtok (20°C, pH - 6.7). Green filamentous mat, 14.09.2008, V.N. – 1809.

68. ***Rivularia mesenterica** Thur.; Thur. 1875, P. 382 **(Pl. 2, Fig. 3)**

Thallus brownish green, trichome unbranched with basal heterocyst, sheathed, sheath free after certain distant from the base of the filament.

Odisha: Pradhanpat, Deogarh (pH- 7.2). Epilithic on rock surface; 28.07.2008, V.N.– 1653; Odisha: Harishankar, Balangir (pH - 6.7). Bluish green epilithic biofilm, 27.07.2008, V.N.– 1652.

69. **Microchaete uberrima** Carter; Mishra 2005, p. 71, pl. 2, fig. 15 **(Pl. 6, Fig. 19)**

Thallus blue green, filamentous, elongated, cylindrical, sheathed, matured cells cylindrical, young cells sub quadrate, cells 10 µm broad and 13.2 µm long.

West Bengal: Tiger hill, Darjeeling. Epilithic green, slimy biofilm; 10.09.2008, V.N.– 1763; Sikkim: Hanuman tok, Gangtok (18°C; pH - 6.8). Floating mass, 12.09.2008, V.N. – 1784.

70. **Tolypothrix distorta** Kütz. ex Born. & Flah. ; Desikachary, 1959, P. 495, Pl.102, fig.1 **(Pl. 6, Fig. 20)**

Thallus bluish green, filamentous, pseudobranched, heterocystous, heterocyst basal or intercalary, rectangular, longer than broad, cell rectangular, 9.5-10.5 µm broad, 14-16 µm long, slightly constricted at cross walls, granulated.

Sikkim: Lachung. Blackish to grey epilithic biofilm, 14.06.2010, V.N. – 2539.

71. **Tolypothrix robusta** Gardner; Desikachary 1959, P. 499, Pl. 102, Fig. 3 **(Pl. 2, Fig. 4)**

Thallus bluish green, filamentous, pseudo-branched, sheathed, sheath 2 µm thick, heterocyst at the base of the pseudo-branch, cells longer than broad, 8-11 µm, rectangular, 8 µm broad.

Odisha: Pradhanpat, Deogarh (pH- 7.2). Epilithic on rock surface; 28.07.2008, V.N.– 1653.

72. ***Anabaena affinis** Lemmerm.; Geitler 1925, P.320, Fig. 374 **(Pl. 2, Fig. 5)**

Thallus bluish-green, trichome solitary, straight to slightly bent, deeply constricted at crosswalls, not attenuated, heterocystous, heterocyst rounded, 7.5 µm in diameter, cells with median constriction with central aerotopes, 5.7 µm broad, 8.5 µm long, end cells rounded.

Odisha: Huluhula, Ganjam. Epilithic biofilm, 17.05.2008, V.N. – 1520.

73. **Anabaena constricta** (Szafer) Geitler; Geitler 1925, p. 312, fig. 360; Basionym – *Oscillatoria constricta* Szafer **(Pl. 2, Fig. 6)**

Trichomes free floating, blue green, cells barrel shaped, slightly constricted at the middle, 5.5-6 µm long and 3.2 µm broad, heterocysts rarely present, akinetes elliptical, 7.5 µm long and 3.5 µm broad.

Odisha: Huluhula, Ganjam. Epipsammic mat, 20.04.2008, V.N. – 1488; Odisha: Nrushinghanath, Baragarh. Bluish green epilithic biofilm; 18.09.2010; V.N.– 2653.

74. **Aulosira bombayensis** Gonzalves; Desikachary 1959, P. 426, Pl. 82, Fig.2 **(Pl.1, Fig. 26)**

Filament bluish green, sheath firm, lamellated, trichome constricted, cells longer than broad, 8 µm long, 3.6 µm broad, heterocyst intercalary, cylindrical, as long as vegetative cell.

Odisha: Pradhanpat, Deogarh (pH- 7.2). Epilithic on rock surface; 28.07.2008, V.N.– 1653; Odisha: Harishankar, Balangir (pH - 6.7). Bluish green epilithic mass under flowing water, 27.07.2008, V.N.– 1647.

75. **Aulosira fertilissima** Ghose var. **tenuis** C.B. Rao; Desikachary 1959, p. 431, pl. 80, figs. 2-5 **(Pl. 6, Fig. 21)**

Filament straight or little flexuous, sheathed, 7.5-8.5 µm wide, trichome blue green, cells cylindrical, longer than broad in young filaments, 4 µm broad and 12.5 µm long; in older filament the cells barrel shaped and contain granules; sheathed at first, gelatinous and hyaline, later firm and brown; heterocyst intercalary, oblong 5-7 µm broad and 12-15 µm long.

Sikkim: Pastanga (20°C, pH - 6.7). Epilithic on moist rocks, 14.09.2008, V.N. – 1800.

76. **Nostoc commune** Vaucher ex Born. & Flah. ; Desikachary 1959, p. 387, pl. 68, fig. 3; Synonym - *Nostoc kutzingianum* Zeller, *Nostocella communis* (Vaucher) Gaillon, *Tremella nostoc* Linnaeus **(Pl. 6, Fig. 24)**

Thallus bluish green, ovate, gelatinous; filaments flexuous, entangled; sheath mostly distinct at periphery, thick, yellowish brown, lamellate, trichome 2 µm broad, cells nearly spherical, isodiametric, heterocyst spherical.

Odisha: Pradhanpat, Deogarh (pH- 7.2). Epilithic on rock surface; 28.07.2008, V.N. – 1653; Sikkim: Pastanga (20°C, pH - 6.7). Epilithic on moist rocks, 14.09.2008, V.N. – 1800.

77. **Nostoc muscorum** C. Agardh ex Born. & Flah.; Desikachary 1959, p. 385, pl. 70, fig. 2 **(Pl. 6, Fig. 22)**

Trichome bluish green, flexous, straight, sheath indistinct, deeply constricted at the cross walls; cells barrel shaped, 3.3 µm broad and 3.6 µm long, end cell rounded, heterocyst 4.7 µm long, cells granulated, with aerotope.

Mizoram: Phunchawang. Epilithic biofilms, 24.03.2008, V.N. - 1420.

78. **Nostoc spongiaeforme** var. **varians** C.B. Rao; Desikachary 1959, p. 380-381, pl. 67, fig. 3 **(Pl. 6, Fig. 23)**

Thallus blue green, cell barrel shaped 5-5.6 µm broad and 4.2-7 µm long; heterocyst rounded, intercalary, broader than the trichome, 5.5-7 µmin diameter; end cells conical with rounded ends.

West Bengal: Rock garden, Darjeeling (20°C, pH - 6.8). Epilithic biofilm, 10.09.2008, V.N. – 1775.

CHLOROPHYTA

ORDER – ZYGNEMATALES

1. **Spirogyra affinis** (Hassall) Petit; Randhawa 1959, p. 300, fig. 261 a; Basionym – *Zygnema affine* Hassal; Synonym *Spirogyra suecica* Transeau, *Zygnema affine* Hassal **(Pl. 6, Fig. 25)**

Thallus greenish, filamentous, filament bent, not constricted, plane cross wall, rhizoid like structure present in the filament, cells cylindrical, longer than broad, 35-37.5 µm long and 9-11 µm broad, chloroplast single, spiral.

West Bengal: Ganga maya park, Darjeeling. Green filamentous mat; 10.09.2008, V.N.– 1768; Sikkim: Hanumantok, Gantok (18°C, pH - 6.8). Epilithic biofilm, 12.09. 2008, V.N.– 1781.

2. **Spirogyra esthonica** (Skuja) Czurda; Randhawa 1959, p. 396, fig. 460 a **(Pl. 6, Fig. 26)**

Thallus green, filamentous; cells cylindrical, longer than broad, 26 µm broad and 83-90 µm long, cross wall plane, chloroplast single, spiral, making 3-4 turns in a cell.

Sikkim: Hanuman tok, Gangtok (18°C; pH - 6.8). Floating mass, 12.09.2008, V.N. – 1783.

3. ***Spirogyra hydrodictya** Transeau; Randhawa 1959, p. 409, fig. 492 (a-c) **(Pl. 6, Fig. 27)**

Vegetative cells 80-100 µm broad and 150-200 µm long, cross walls plane, 7-10 chloroplasts, straight or making 0.1-0.5 turn per cell; conjugation scalariform and lateral; tubes formed by the male gametangia; fertile cells short, inflated; zygospore lenticular to lenticular-globose, 80-100 µm broad and 100-125 µm long.

Mizoram: Phunchawang. Epilithic biofilms, 24.03.2008, V.N.- 1427.

4. **Spirogyra maravillosa** Transeau; Randhawa 1959, p. 388, fig. 443 **(Pl. 7, Fig. 1)**

Cells are cylindrical, 2-4 times longer than broad, 28.5 µm broad and 63-114 µm long, cross wall plane, not constricted, apical cell rounded, 2-3 spiral chloroplasts per cell, reproduction stage not found in the sample.

Odisha: Narayani, Khurda (29°C, pH- 6.8). Epilithic biofilm, 02.10.2008, V.N.- 1866; Odisha: Ghagra, Keonjhar. Filamentous mat, 25.11.2008, V.N.- 2069; Odisha: Nrushinghanath, Baragarh. Bluish green epilithic biofilm; 18.09.2010; V.N.– 2662; West Bengal: Gangamaya park, Darjeeling. Submerged mat attached to rock; 10.09.2008, V.N.– 1767; Sikkim: Hanuman tok, Gangtok (18°C; pH - 6.8). Floating mass, 12.09.2008, V.N. – 1783.

5. **Spirogyra parvula** (Transeau) Czurda; Randhawa 1959, p. 298, fig. 259; Synonym – *Spirogyra catanaeformis* var. *parvula* Transeau **(Pl. 7, Fig. 2)**

Vegetative cells 23 – 35 µm broad, 81 - 90 µm long, each cell has one chromatophore of 2 – 4 turns, plane septa.

Arunachal Pradesh: Jaswant garh. Floating in stream; 29.10.2010; V.N.– 2694.

6. ***Spirogyra pseudoreticulata** Krieger; Randhawa 1959, p. 401, fig. 471 a; **(Pl. 2, Fig. 7)**

Filament green, long, straight; cells cylindrical, 6-7 times longer than broad, 10-12µm broad and 75 µm long, cross wall plane, not constricted, 2 loosely regular coiled chloroplast, 2-3 turns per cell, cell apices rounded, pyrenoid absent.

Odisha: Harishankar, Balangir (pH - 6.7). Brownish epilithic biofilm, 27.07.2008, V.N.– 1646; Odisha: Ghagra, Keonjhar. Filamentous mat, 25.11.2008, V.N.- 2080; Odisha: Sitakund, Mayurbhanj. Epilithic biofilm, 06.10.2008, V.N. – 2033.

7. **Spirogyra rhizoids** Randhawa; Randhawa 1959, p. 328, fig. 316 **(Pl. 2, Fig. 8)**

Filament straight, green, the apical cells blunt and spatulate, basal part with rhizoids fixed to the substratum, vegetative cell 22.5 µm broad, 3 chloroplasts per cell spirally arranged.

Odisha: Phurlijharan, Kalahandi (20°C, pH-6.2). Long green filamentous mat attached to rock, 23.03.2009, V.N.- 2382.

8. **Spirogyra rhizopus** Jao; Randhawa 1959, P.331, fig. 321 **(Pl. 7, Fig. 3)**

Thallus filamentous, green, vegetative cell longer than broad, rectangular, cross wall plane, chloroplast single, spirally coiled, with pyrenoids, attached with the rock substratum with rhizoidal structures, cells 8.5-15 µm long, 5.6 µm broad.

Sikkim: Gurudongmar, Sikkim; Habitat – outlet stream of lake 15.06.2010, V.N. – 2544.

9. **Zygnema pseudopunctinatum** Czurda; Randhawa 1959, P. 218, Fig. 145 **(Pl. 7, Fig. 4)**

Filament greenish, long, slightly constricted at cross walls, cells rectangular, chloroplasts 2, star shaped, cell apex widely rounded, cells 36-38 µm long, 22 µm.

Sikkim: Chungthang. Green filamentous mat, 17.06.2010, V.N. – 2563.

10. **Rhizoclonium heiroglyphicum** (Ag.) Kuetz.; Prasad & Srivastava 1992, II, P. 56, Pl. 7, Fig. 7-8 **(Pl. 2, Fig. 9)**

Thallus greenish, filamentous, unbranchd, 2-4 celled rhizoidal branches, cells cylindrical, longer than broad, plane cross wall, not constricted, 9 µm broad, 15-28 µm long, cell with filled chloroplasts.

Odisha: Narayani, Khurda (29°C, pH- 6.8). Epilithic biofilm, 02.10.2008, V.N.- 1866.

11. ***Rhizoclonium pachydermum** Kjellm.; Kjellmann, 1877, P. 55 **(Pl. 2, Fig. 10)**

Thallus greenish, filamentous, unbranchd, with 1-2 celled rhizoidal branches, cells cylindrical, longer than broad, plane cross wall, not constricted, 9 µm broad, 15-28 µm long, cell with filled chloroplasts.

Odisha: Pradhanpat, Deogarh (pH- 7.2). Epilithic on rock surface; 28.07.2008, V.N.– 1657.

12. **Sirocladium kumaoense** Randhawa, Randhawa 1959, P. 434, fig. 518 **(Pl. 2, Fig. 11)**

Filament greenish, basal cell with rhizoids, vegetative cells cylindrical, cross wall plane, chloroplast parietal with pyrenoids, cell 45-50 µm long, 12-15 µm broad.

Odisha: Pradhanpat, Deogarh (pH- 7.2). Epilithic on rock surface; 28.07.2008, V.N.– 1657.

13. **Gonatozygon kinahani** (Arch.) Rabenh.; West and West 1904, P. 35, fig. 1-3 **(Pl. 3, Fig. 1)**

Cells long, cylindrical, joined end to end forming a pseudo-filament, constricted at cross walls, cell 82.87-100 µm long, 11.5 µm broad, cell wall smooth, one axial chloroplast in each semicell with median small pyrenoid.

Odisha: Ghagra, Keonjhar. Epixylic, 25.11.2008, V.N.- 2072.

14. **Cylindrocystis brebisonii** Meneghini; Ettl & Gärtner 1995, p. 615, fig. 208 f **(Pl. 2, Fig. 12)**

Cell solitary, cylindrical, slightly depressed at middle, longer than broad, apices broadly rounded, chloroplast axile, stellate, one in each half with a large central pyrenoid; cell 32.5 µm long and 18.7µm broad.

Odisha: Huluhula, Ganjam. Epipsammic mat, 20.04.2008, V.N. – 1488; Odisha: Nrushinghanath, Baragarh. Epiphytic; 18.09.2010; V.N. – 2669.

15. **Cylindrocystis crassa** De Bory; Ettl & Gärtner 1995, p. 617, fig. 208 I **(Pl. 2, Fig. 13)**

Cell solitary, short, cylindrical, slightly median constricted, rounded apices, 29.7 µm long and 20.2 µm broad, each semicell with a stellate chloroplast containing one large pyrenoid at the centre.

Odisha: Huluhula, Ganjam. Epipsammic mat, 20.04.2008, V.N. – 1488.

16. ***Cylindrocystis obesa** West & G. S. West; West and West 1904, P. 60, fig. 8 **(Pl. 2, Fig. 14)**

Cell solitary, single, unconstricted, broadly lanceolated with rounded apices, each semicell with a stellate chloroplast containing a pyrenoid at centre, cell 25-27µm broad at the middle, 36 µm long.

Odisha: Ghagra, Keonjhar. Epixylic, 25.11.2008, V.N. - 2072.

17. **Cylindrocystis ovalis** Turn. Turner 1892, p. 16, pl. 1, fig. 5 **(Pl. 7, Fig. 6)**

Cells solitary, oval or broadly lanceolate, broader at middle, slightly constricted, apices rounded, 35 µm long, 22.5 µm broad, each semicell with a stellate chloroplast containing one pyrenoid in the centre.

Sikkim: Hanumantok, Gantok (18°C). Filamentous mat, 12.09. 2008, V.N.– 1780.

18. **Netrium digitus** (Ehrenb.) Itzigsh et Rothe. Prasad and Mishra 1992, p. 89, pl. 15, fig. 2 **(Pl. 2, Fig. 15)**

Cell linear, oblong, elliptic, not constricted, 140-152 µm long, 40 µm broad at middle, narrower towards both end, apices rotundo-truncate, cell wall smooth, chloroplast with longitudinal plate and deeply serrarted margin.

Odisha: Nirmalajhara, Ganjam. Slimy epilithic biofilms, 17.05.2008, V.N. – 1506; Odisha: Nrushinghanath, Baragarh. Epiphytic; 18.09.2010; V.N. – 2669.

19. **Penium margaritaceum** Ralfs.; West and West 1904, P. 83, Pl. VIII, Fig. 32 **(Pl. 2, Fig. 17)**

Cell solitary, straight, elongated, with broadly rounded ends, cell wall smooth with slightly constricted along the margin, semicells with narrow sinus, cell 22µm broad, 172µm long.

Odisha: Phurlijharan, Kalahandi (20°C, pH-6.2). Epilithic biofilm with filamentous algae, 23.03.2009, V.N. – 2386.

20. ***Penium navicula** Bréb.; West & West 1904, Vol. I. P. 75, Figs. 12-15 **(Pl. 2, Fig. 16)**

Cell solitary, linear, straight, naviculate or broadly lanceolated with truncated ends, longer than broad, 33 µm long, 11 µm broad, cell wall smooth, chloroplast one in each semicell, pyrenoids arranged in a median series.

Odisha: Nirmalajhara, Ganjam. Slimy epilithic biofilms, 17.05.2008, V.N.– 1503; Odisha: Phurlijharan, Kalahandi (20°C, pH-6.2). Epilithic biofilm with filamentous algae, 23.03.2009, V.N. – 2386.

21. **Closterium acerosum** (Schrank) Ehrenb.; Pal & Santra 1993, p. 148, pl. 1, fig. 2; Synonym – *Vibrio acerosum* Schrank **(Pl. 2, Fig. 18)**

Cell solitary, greenish, cylindrical, attenuated towards the end, chloroplast divided into 2 parts, a single polar nodule present at each end, cells 357 - 380 µm long, 36 - 40 µm broad and pole 6 - 9 µm broad.

Odisha: Ghagra, Keonjhar. Filamentous mat, 25.11.2008, V.N.- 2076; Odisha: Huluhula, Ganjam. Epipsammic mat, 20.04.2008, V.N. – 1488.

22. **Closterium calosporum** Wittrock; Pal & Santra 1993, p. 148, pl. 1, fig. 5; Synonym – *Closterium calosporum* f. *minus* Huber – Pestalozii **(Pl. 2, Fig. 19)**

Cells solitary, green, sickle shaped, attenuated, chloroplasts 2, pyrenoids many, not arranged in a row, cell 73.9 µm long and 11.5 µm broad, poles 2.7 µm broad.

Odisha: Pradhanpat, Deogarh (pH- 7.2). Epilithic on rock surface; 28.07.2008, V.N.– 1653.

23. **Closterium moniliferum** (Bor.) Ehrenb. f. Bour.; Prasad & Misra 1992, p. 113, pl. 12, fig. 4 **(Pl. 7, Fig. 5)**

Cells of medium size, moderately curved, cells uniformly narrowed to obtusely rounded apices, cell wall smooth, cells longer than broad,120 - 150 µm long, 11 - 22 µm broad, apex 5.5 - 6 µm broad.

Arunachal Pradesh: Jaswantgarh. Epilithic; 29.10.2010; V.N.– 2698.

24. ***Euastrum gangense** Turn.; Turner 1892, p. 87, pl. XI, fig. 20 **(Pl. 2, Fig. 20)**

Cell solitary, rhomboidal with deep sinus, margine denticulate, semicells narrowed into a wide rounded end, semicells 40 µm long, 54 µm broad at middle, isthmus 20 µm wide, cell content granular.

Odisha: Phurlijharan, Kalahandi (20°C, pH-6.2). Brownish biofilm, 23.03.2009, V.N.- 2390.

Odisha: Ghagra, Keonjhar. Epiphytic, 25.11.2008, V.N.- 2080.

25. **Staurastrum bieneanum** Rabenh. var. **ellipticum** Wille fa. Skuja; Misra & Srivastava 2003, p. 90, pl. 1, fig. 12 **(Pl. 7, Fig. 7)**

Cells slightly broader than long, deeply constricted, sinus widely open, semi cells narrowly elliptic, 22 µm long, 24 µm broad and isthmus 9.5 µm broad.

Odisha: Nirmalajhara, Ganjam. Slimy epilithic biofilms, 17.05.2008, V.N. – 1505; Arunachal Pradesh: Sangey. Epilithic, 29.10.2010, V.N. – 2684, 2695.

26. ***Staurastrum donardense** West & West; West and West 1912, P. 169, Pl. 126, Fig. 7 **(Pl. 2, Fig. 22)**

Cell solitary, planktonic, slightly longer than broad, 42 µm long, 33.5 µm broad, deeply constricted, sinus wide opened, isthmus 14 µm wide, margin rough, cell surface denticulate throughout.

Odisha: Phurlijharan, Kalahandi (20°C, pH-6.2). Epipelic blackish biofilm, 23.03.2009, V.N.- 2378; Odisha: Ghagra, Keonjhar. Epiphytic, 25.11.2008, V.N.- 2080.

27. **Staurastrum striolatum** (Näg.) Arch.; West & West 1912, P. 177, Pl. 127, Fig. 1-5 **(Pl. 2, Fig. 23)**

Cell solitary, longer than broad, bilaterally symmetrical, 19 µm long, 9.2 µm broad, deep median constriction, semicells triangular with rounded ends, cell wall rough or dentate, chloroplast axial.

Odisha: Phurlijharan, Kalahandi (20°C, pH-6.2). Epiphytic, 23.03.2009, V.N.- 2382.

28. **Cosmarium angulatum** (Perty) Rabenh.; Turner 1892, p. 56, pl. IX, fig. 25; Basionym – *Euastrum angulosum* Ehrenb.; Synonym – *Euastrum angulatum* Perty **(Pl. 2, Fig. 24)**

Cell elongated, less constricted at middle; semi cells with obtuse rounded apices, one semicell straight and other slightly curved, smooth margin, one pyrenoid in each semicell, cell 59 µm long and 24 µm broad, isthmus 21 µm wide.

Odisha: Pradhanpat, Deogarh (pH- 7.2). Epilithic on rock surface; 28.07.2008, V.N. – 1653; Odisha: Ghagra, Keonjhar. Epiphytic, 25.11.2008, V.N. - 2080.

29. **Cosmarium difficile** Lütkemüller var. **sublaeve** Lütkem.; W. & G.S. West 1908, p. 97, pl. 73, fig. 5 **(Pl. 2, Fig. 25)**

Cells solitary, greenish, rectangular, longer than broad, sinus slightly constricted, closed, semicells subquadrangular, outer wall plane, basal angles broadly rounded, apex flattened, cell wall smooth, cells 26.4 µm long and 17.8 µm broad, isthmus 3.5 µm broad.

Odisha: Narayani, Khurda (29°C, pH- 6.8). Epipelic, 17.05.2008, V.N.- 1499.

30. **Cosmarium formosulum** Hoff.; Mishra and Srivastava 2003, p. 87, pl. 1, fig. 19; Vidyavati 1982, p.632-634, figs. 1-A-F **(Pl. 7, Fig. 9)**

Cell longer than broad, deeply constricted, sinus linear, semi cells broadly ovate, less unequal. Margin slightly crenate, apices of semi cells slightly compressed, cell 40 µm long, 29.3 µm broad at middle, isthmus 12.8 µm wide.

Sikkim: Hanuman tok, Gangtok (18°C; pH - 6.8). Floating mass, 12.09.2008, V.N. – 1780.

31. ***Cosmarium granatum** Bréb. in Ralfs. var. **ocellatum** W & West; Williamson 2006, p. 66, pl. 2, fig. 13 **(Pl. 2, Fig. 26)**

Cell small, longer than broad, 35 µm long, 25 µm broad at middle, deeply constricted, sinus close, 11 µm wide, semi cells truncate-pyramidate, basal angles rounded, apical angles obtuse, apex truncate with slightly depression, cell wall finely punctuate, chloroplasts axile.

Odisha: Nirmalajhara, Ganjam. Slimy epilithic biofilms, 17.05.2008, V.N.– 1503.

32. **Cosmarium inaequalipellicum** West & West; West and West 1908, P. 266, Pl. XCI, Fig.4-5 **(Pl. 2, Fig. 27)**

Cell solitary, truncated, apices, sinus close, with a wide isthmus, cell slightly longer than broad, 23.75 µm long, 18 µm broad, 9.3 µm wide isthmus, chloroplast axial, bilobed with one pyrenoids each.

Odisha: Narayani, Khurda (29°C, pH- 6.8). Epipelic, 17.05.2008, V.N.- 1500.

33. **Cosmarium lundellii** Delponte var. **ellipticum** West & West; Prasad & Misra 1992, p. 164, pl. 22, fig. 10; Synonym – *Cosmarium lundelii* f. *minus* Strom **(Pl. 2, Fig. 28)**

Cell of medium size, a little longer than broad, deeply constricted, sinus closed, semi cells sub semicircular with relatively broader and rounded apices, cell wall minutely punctate, cell 60 µm long, 40-45 µm broad, isthmus 8.1 µm broad.

Odisha: Barunei, Khurda. V.N.- Epilithic biofilm in the stream, 17.05.2008, 1492; Odisha: Ghagra, Keonjhar. Epiphytic, 25.11.2008, V.N.- 2080.

34. **Cosmarium maculiforme** Schmidle; Asoka Kumar & Patel 1990, Pl.1, Fig. 18 **(Pl. 2, Fig. 29)**

Cell solitary, linear to ellipsoidal, sinus narrow, not so deep, semicells hemispherical, cell wall smooth, regularly punctate, chloroplast two in each semicell, axial with longitudinal plates, cells 130 µm long, 74 µm broad at middle, Isthmus 50 µm wide.

Odisha: Ghagra, Keonjhar. Epiphytic, 25.11.2008, V.N.- 2080; Date of collection – 25.11.2008. Odisha: Nirmalajhara, Ganjam. Slimy epilithic biofilms, 17.05.2008, V.N.– 1503.

35. **Cosmarium microsphintum** f. **parvula** Wille; West & West 1905, P. 157, Pl. LX, Fig.9 **(Pl. 7, fig. 10)**

Cell solitary, unicellular, longer than broad, 50 µm long, 26 µm broad, cell broadly lanceolate with truncated at both end, middle part sinuated, chloroplast 2 with one pyrenoid each.

Sikkim: Lachung. Blackish to grey epilithic biofilm, 14.06.2010, V.N. – 2533.

36. **Cosmarium nitidulum** De Notar. ; Prasad & Misra 1992, p. 168, pl. 22, fig. 17, 21; Synonym – *Euastrum nitidulum* (De Notaris) Gay **(Pl. 2, Fig. 30)**

Cell small, slightly longer than broad, deeply constricted, sinus narrowly linear with slightly dilated apex, semicells truncate-subsemicircular, tapering evenly from rounded basal angles to flattened apex with straight margin, cell wall minutely punctate, chloroplast monocentric with one pyrenoid, cell 29 µm long, 23 µm broad, isthmus 6 µm broad.

Odisha: Phurlijharan, Kalahandi (20°C, pH-6.2). Strongly attached filamentous patch on rock surface, 23.03.2009, V.N.- 2382; Odisha: Ghagra, Keonjhar. Epiphytic, 25.11.2008, V.N.- 2080.

37. **Cosmarium praecisum** Bor.; Ashok Kumar& Patel 1990, p. 98, pl. 1, figs. 23, 24 **(Pl. 7, Fig. 11)**

Cell small, quadrate, little longer than broad, 11.4 µm long, 10 µm broad, isthmus 6.5 µm broad, sinus narrow, semi cells rectangular, cell wall smooth.

Sikkim: On the way to Pastanga, Gangtok (20°C, pH - 6.7). Epilithic biofilm, 10.09.2008, V.N. – 1806; Sikkim: Ranipool, Gangtok (20°C, pH - 6.7). Epilithic biofilm, 14.09.2008, V.N. – 1806.

38. **Cosmarium quadrum** Lund var. **andamanicum** Prasad & Mishra; Prasad and Mishra 1992, p. 178, pl. 23, figs. 1, 2 **(Pl. 2, Fig. 31)**

Cells quadrate, nearly as long as broad, 40 µm long, 38 µm broad at middle, deeply constricted, sinus close, semi cells sub rectangular, basal and apical angle rounded, sides convex, apex slighltly depressed inside, cell wall granulated, each semi cell with an axile chloroplast.

Odisha: Nirmalajhara, Ganjam. Slimy epilithic biofilms, 17.05.2008, V.N.– 1503.

39. ***Cosmarium quadrifarium** var. **oblonga** Kant & Gupta; Kant & Gupta 1998, p. 135, pl. 117, fig. 8 **(Pl. 7, Fig. 12)**

Cells oblong, sub cylindrical, semi cells almost spherical, cell wall smooth, isthmus medium, deeply constricted chloroplast small plate like, one in each semi cell; cell 18.9 µm long and 10 µm broad, isthmus 5.5 µm broad.

Sikkim: Pastanga (20°C, pH - 6.7). Epilithic on moist rocks, 14.09.2008, V.N. – 1800.

40. **Cosmarium radiosum** Wolle; Prasad & Srivastava 1992, p. 179, pl. 24, fig. 12 **(Pl. 7, Fig. 13)**

Cells longer than broad, deeply constricted, sinus narrowly linear with slightly dilated extremity, semi cells sub-semicircular, sides strongly convex, apex rounded, semi cells 37 - 40 µm long, 30 - 31 µm broad, isthmus 12.5 µm broad.

Arunachal Pradesh: Jaswant garh. Epilithic; 29.10.2010, V.N.– 2695.

41. **Cosmarium turgidum** (Bréb.) Ralf var. **subrotundatum** West & West; Pasad and Misra 1985, P. 346, Fig.1 **(Pl. 2, Fig. 32)**

Cells large, about 1.5 times longer than broad with shallow constrictions, semicells slightly inflated and sub circular, 70 µm long, 50 µm broad, isthmus 44 µm wide, cell wall distinctly and sparsely punctate.

Odisha: Nirmalajhara, Ganjam. Slimy epilithic biofilms, 17.05.2008, V.N.– 1506.

42. **Pleurotaenium ehrenbergii** (Brébisson) De Bory; Prasad & Misra 1992, p. 124, pl. 18, fig. 9, 10; Basionym – *Docidium Ehrenbergii* Brébisson ex Ralfs; Synonym - *Docidium Ehrenbergii* Brébisson ex Ralfs, *Docidium Ehrenbergii* var. *delpontei* Playfair, *Pleurotaenium Ehrenbergii* var. *constrictum* (Playfair) Krieger, *Pleurotaenium Ehrenbergii* var. *granulatum* (Ralfs) West & G.S. West, *Docidium dilatatum* (Cleve) Lundell, *Docidium Ehrenbergii* var. *elongatum* W. West. **(Pl. 3, Fig. 2)**

Cells cylindrical with truncate apices, median constriction, semi cells attenuated at the poles, cell wall smooth, uniform diameter throughout, cells many times longer than broad, 150 µm long and 5 µm broad.

Odisha: Nirmalajhara, Ganjam. Slimy epilithic biofilms, 17.05.2008, V.N.– 1506.

43. **Micrasterias pinnatifida** (Kütz.) Ralfs; Prasad & Misra 1992, p. 143, pl. 20, fig.4; Synonym – *Micrasterias oscitans* var. *pinnatifida* (Kütz. ex Ralfs) Rabenhorst **(Pl. 3, Fig. 3)**

Cells small, slightly broader than long, deeply constricted, sinus linear but slightly open outwards, semicells 3 lobed, interlobular incisions deep outwards and broadly rounded, lateral lobes horizontal, semifusiform with minutely bifid, apices exhibiting acuminate ends, polar lobe with basal portion subrectangular, apical portion with lateral lobes, shorter in length, cell 54.3 - 57 µm long, 64.3 - 71 µm broad and isthmus 7 – 8.5 µm broad.

Odisha: Phurlijharan, Kalahandi (20°C, pH-6.2). Epiphytic, 23.03.2009, V.N.- 2382.

44. ***Actinotaenium cucurbita** (Breb.) Teiling; Ettl & Gärtner 1995, P.622, fig. 209e; Synonym- *Cosmarium cucurbita* Bréb. **(Pl. 3, Fig. 4)**

Cell solitary, ellipsoidal, slightly truncated at both end, slightly constricted at middle, 40 µm long, 21.5 µm broad at middle.

Odisha: Harishankar, Balangir (pH - 6.7). Brownish epilithic biofilm, 27.07.2008, V.N.– 1646.

45. **Coleochaete scutata** Bréb.; Prescott 1961, p. 130, pl. 18, fig. 9 **(Pl. 7, Fig. 14)**

Discoid thallus, 12 – 13.6 µm in diameter, filaments compactly arranged, radiating from a common centre, cells quadrangular.

Arunachal Pradesh: Sangey. Epilithic, 29.10.2010, V.N. – 2687.

46. **Ulothrix tenuissima** Kütz.; Prasad and Srivastava 1992, p. 45, pl. 6, fig. 8; Synonym - *Ulothrix tenuis* Kütz. **(Pl. 7, Fig. 15)**

Filament long, uniseriate, not constricted at cross walls, cells broader than long, 11 µm broad, 6 µm long, cell wall thin, plane, chloroplast parietal, encircling two third or more of the cell width.

West Bengal: Chitrey, Kalimpong (29°C; pH - 6.8). Slimy epilithic biofilms, 08.09.2008, V.N.– 1755; Sikkim: Kyongnosola (14°C, pH – 6). Bluish green patch attached to rock surface; 12.09.2008, V.N.– 1789.

47. **Stigeoclonium curvirostrum** Skuja; Keshri 2009, P.49, Figs. 16-18 **(Pl. 7, Fig. 16)**

Thallus greenish, filaentous, true branched, branching dichotomus, cell wall no constricted, longer than broad, 24-50 µm long, 8 µm broad, apical cell attenuated into acute apex, chloroplast girdle shaped lined with protoplast.

Sikkim: Chungthang. Bluish green to grey green slimy epilithic biofilm, 17.06.2010, V.N. – 2569.

48. **Stigeoclonium longipilum** Kütz. & Islam; Keshri 2009, P.51, Figs. 23-26 **(Pl. 7, Fig. 17)**

Filament greenish, branched, crosswall slightly constricted, chloroplast girdle shaped with pyrenoids, cells longer than broad, 14-25 µm long, 7 µm broad, branch tip blunt to slightly pointed.

Odisha: Pradhanpat, Deogarh (pH- 7.2). Epilithic on rock surface; 28.07.2008, V.N.– 1654; Sikkim: Chungthang. Submerged green filaments, 17.06.2010, V.N.– 2563.

49. **Epibolium polyspermum** Düringer; Keshri 2009, P.46, fig. 9-10 **(Pl. 7, Fig. 18)**

Filament brownish green, attached to rock surface, entangled, branced, cells rectangular to bulky irregular, cell contents golden brown due to metal accumulation, cell wall slightly constricted, cells 18-30 µm long, 10-13 µm broad.

Sikkim: Naga waterfall, Lachung. Blackish to grey epilithic biofilm, 14.06.2010, V.N. – 2540.

50. **Radiofilum transversalis** (Bréb.) Ramanathan; Ramanathan 1964, p. 75, pl. 20 (a), fig. F – H **(Pl. 7, Fig. 19)**

Filaments pseudomembranous, cells ellipsoidal, plate like, 3 - 3.5 µm long and 2.2 – 2.4 µm broad, sometimes divided in both horizontal and longitudinal plane, branches present.

Arunachal Pradesh: Sangey. Epilithic, 29.10.2010, V.N. – 2686.

51. **Cladophora glomerata** (Linn.) Kütz.; Krishnamurthy 2000, p. 139, fig. 18 B-H; Basionym – *Conferva glomerata* Linnaeus; Synonym – *Cladophora tildeniae* Brand, *Cladophora cristata* f. *maura* Lewin, *Cladophora declinata* var. *fluitans* (Kütz.) Hansg. **(Pl. 3, Fig. 6)**

Thallus filamentous, branched, branches making acute angle with the axes; apical cell bluntly rounded, cells 250 µm long and 20-60 µm broad.

Odisha: Pradhanpat, Deogarh (pH- 7.2). Planktonic; 28.07.2008, V.N. – 1654; Odisha: Narayani, Khurda (29°C, pH- 6.8). Epipelic, 17.05.2008, V.N. - 1500; Odisha: Phurlijharan, Kalahandi (20°C, pH-6.2). Strongly attached filamentous patch on rock surface, 23.03.2009, V.N. - 2382.

ORDER – CHLOROCOCCALES

52. **Pediastrum tetras** (Ehrenb.) Ralfs; Komárek & Jankovska 2001, p. 68, fig. 43; Basionym – *Micrasterias tetras* Ehrenb.; Synonym – *Pediastrum Ehrenb.ii* (Corda) A. Braun **(Pl. 3, Fig. 7)**

Coenobia 8 celled, circular, 22 µm in diameter, cells without intercellular spaces, marginal cells divided into 2 lobes with a deep single linear incision, inner cell 4-6 sided with a single linear incision, cells 6.3 µm in diameter.

Odisha: Huluhula, Ganjam. Epipsammic mat, 20.04.2008, V.N. – 1488.

53. **Pediastrum tetras** var. **tetraodon** (Corda) Hansg.; Philipose 1967, p. 129, fig. 45 e **(Pl. 3, Fig. 8)**

Colonies 8-16 celled, circular without intercellular space; marginal cell divided into two lobes by a deep linaear to cuneate incision on the outerside reaching to the middle of the cell; each lobe truncate, slightly emarginated, further divided into two lobes; cells 7 µm in diameter, colony 25µm in diameter in 8 celled stage.

Odisha: Huluhula, Ganjam. Epipsammic mat, 20.04.2008, V.N. – 1488.

54. ***Ecballocystopsis dichotomus** Hu Zheng-Yu; Hu Zheng-Yu & Bi Lie-Jue 1998, p. 403-408 **(Pl. 7, Fig. 21)**

Thallus multicellualar, filamentous, dichotomously branched, branches most of the time forming loops within the filament, sometimes the multiseriate cells look like pseudoparenchymatous, the cell division both longitudinal as well as transverse, the branched loop often joined at a base of a cell with mucilaginous bindings.

Sikkim: Banjhagri fall, Gangtok (22°C, pH - 6). Blue green to grey green, slimy epilithic biofilm, 13.09.2008, V.N. – 1793.

55. **Botryococcus braunii** Kütz.; Komarek and Fott 1983, P. 379, Fig.113.4; Philipose 1967, p. 195, fig. 108; Synonym – *Botryococcus giganteus* Rinsch **(Pl. 3, Fig. 9)**

Colonies free floating, irregular, without a conspicuous gelatinous envelope but completely enclosed by a tough, hyaline, orange colored membrane produced into irregular wrinkles, folds or spines, cells ovoid to ellipsoid, arranged radially at the periphery of the colony, cell 5.2 µm long and 3.3 µm broad, colony 86 µm in diameter.

Odisha: Huluhula, Ganjam. Epipsammic mat, 20.04.2008, V.N. – 1488.

56. **Botryococcus protuberans** West & West; Philipose 1967, p. 197, fig. 109 **(Pl. 7, Fig. 22)**

Colony irregular with 16 or more cells held together; 44 µm in diameter; cells ovoid, the outer ends of the cells projecting out of the colony, cell wall thick, cell 8 µm broad and 14 µm long.

Place of collection - Deolo, Kalimpong, West Bengal; Habitat – Stream, epilithic greenish slimy biofilm; V.N. – 1748; Date of collection - 08.09.2008; Sikkim: Banjhagri fall, Gangtok (22°C, pH - 6). Blue green to grey green, slimy epilithic biofilm, 13.09.2008, V.N. – 1792.

57. **Glaucocystis simplex** Itzigsohn in Rabenh. Komárek and Fott 1983, P. 553, Pl. 160, Fig.4 **(Pl. 7, Fig. 20)**

Colony two celled to four celled, greenish in colour, elliptical, divides longitudinally, resides in a common cell wall during cell division, daughter cell releases by breaking the mother cell wall, chloroplast parietal, cell 13-15 µm long, 8 µm broad.

Sikkim: Lachung. Blackish to grey epilithic biofilm, 14.06.2010, V.N. – 2539.

58. **Desmodesmus spinosus** (Chodat) Hegewald; Hegewald & al., 1990, p. 38, pl. 104 (d); Basionym - *Scenedesmus spinosus* R. Chodat 1913; Synonym - *Scenedesmus brevicauleatus* R. Chodat 1926, *Scenedesmus corallinus* R. Chodat 1926 **(Pl. 7, Fig. 23)**

Coenobia 2-4 celled; cells oblong-ellipsoid arranged in a linear series; single short spine arising at each pole of terminal cell, straight, one spine at the middle of terminal cell; spines 4 - 8 µm long; cell 1.5 -4.0 µm broad and 7.0-10 µm long.

Mizoram: Phunchawang. Epilithic biofilms, 24.03.2008, V.N.- 1426.

59. **Scenedesmus armatus** var. **armatus** Chodat; Hegewald & al. 1990, p. 19, pl. 21, 22, fig. 1, 2 **(Pl. 3, Fig. 10)**

Coenobia 8 celled, cells 17.2 – 18.5 µm long and 5.3 - 6 µm broad, arranged in a linear series, a long spine from each pole of the terminal cell only.

Odisha: Huluhula, Ganjam. Epipsammic mat, 20.04.2008, V.N. – 1488.

60. **Scenedesmus bijugatus** (Turp.) Kütz.; Philipose 1967, p. 252, fig. 164; Basionym – *Heterocarpella bijuga* Turpin; Synonym – *Heterocarpela bijuga* Turpin, *Trochiscia bijuga* (Turpin) Kütz. **(Pl. 7, Fig. 24)**

Coenobia 4 celled, flat, cells arranged in a linear series, cells oblong-ellipsoid to ovoid with the ends broadly rounded, cells 7 – 8 µm long and 2 µm broad.

Arunachal Pradesh: Sangey. Epilithic, 29.10.2010, V.N. – 2684.

61. **Scenedesmus brasiliensis** Bohl. var. **brasiliensis;** Hegewald & al., 1990, P. 29, Pl.74, Fig.1 **(Pl. 3, Fig. 11)**

Coenobia 8 celled, arranged linearly, cells elliptical with acute tip ends with a spine, each cell with median furrow, cell 2.5 µm broad, 5 µm long.

Odisha: Huluhula, Ganjam. Epipsammic mat, 20.04.2008, V.N. – 1488.

62. ***Scenedesmus ecornis** var. **ecornis** Chodat; Komárek & Fott 1983, p. 826, pl. 225, fig. 1 **(Pl. 7, Fig. 25)**

Coenobia 4 celled, cells broadly elliptical, small, with rounded tip, 7.7 – 9.3 µm long and 1.6 µm, cells attached side by side.

Arunachal Pradesh: Jaswant-garh. Epilithic, 29.10.2010, V.N. – 2698.

63. **Scenedesmus ellipticus** Corda; Hegewald & al., 1990, p. 12, pl. 8, fig. 9-13; Synonym – *Scenedesmus ecornis* var. *flexuosus* Lemmerm., *Scenedesmus flexuosus* (Lemmerm.) Ahlstrom, *Scenedesmus linearis* Komárek **(Pl. 3, Fig. 12)**

Coenobia 4 celled, cells arranged in a linear manner, cylindrical or elliptical, obtuse tip, 12.6 µm long and 5.5 µm broad.

Odisha: Phurlijharan, Kalahandi (20°C, pH-6.2). Epilithic biofilm with filamentous algae, 23.03.2009, V.N. – 2386.

64. **Scenedesmus pseudopoliensis** Hortob., Komárek & Fott 1983, p. 910, fig. 245.9 **(Pl. 7, Fig. 26)**

Coenobia 2 celled, arranged in a linear series, cells oblong, slightly truncate at the end, long spine arising at each pole of the terminal cell, spine curved, cells 11 – 13.4 µm long and 3.5 - 4 µm broad.

Place of collection – Siang river, Pasighat, Arunachal Pradesh; Habitat – planktonic; V.N. – 2781; Date of collection – 05.11.2010.

65. **Monoraphidium griffithii** (Berkeley) Komárek – Legnerova; Hindák 1984, p. 219, pl. 79, fig. 5-8; Synonym – *Ankistrodesmus falcatus* var. *acicularis* (Braun) G.S. West, *Closterium griffithii* Berkeley **(Pl. 3, Fig. 13)**

Straight or moderately bent fusiform cells, gradually tapered from the center towards the ends, pointed end, cell 34.5 - 37 µm long and 1.2 – 2.5 µm broad, the group of 4 autospores form a length of 56 - 60 µm.

Odisha: Narayani, Khurda (29°C, pH- 6.8). Epilithic bluish green biofilm, 02.10.2008, V.N.- 1868.

66. ***Monoraphidium fontinale** Hindák; Komárek & Fott, 1983, p. 632, pl. 177, fig. 2 **(Pl. 7, Fig. 27)**

Small thin arcuated cells, slightly bent, 23 - 25 µm long and 2 - 3 µm broad, chloroplast parietal.

Arunachal Pradesh: Jaswant garh. Stream, epilithic; V.N. – 2698; Date of collection – 29.10.2010.

67. ***Microspora amoena** (Kütz.) Rabenh.; Ramanathan 1964, p. 132, pl. 29, fig. A; pl. 30, fig. A**.;** Basionym – *Conferva amoena* Kütz.; Synonym - *Conferva amoena* Kütz. **(Pl. 8, Fig. 5)**

Thallus filamentous, unbranched, thickened cell wall, 5 µm broad, cell 31.3 µm broad, 46-57 µm long, cross wall lamellated; chloroplast parietal, irregularly thickened, completely cover the cell.

Arunachal Pradesh: Sangey. Epilithic, 29.10.2010, V.N. – 2686.

68. **Microspora indica** Randhawa; Ramanathan 1964, p. 132, pl. 37, figs. L-O **(Pl. 8, Fig. 6)**

Thallus greenish, filamentous, unbranched, basal part of filament modified into rhizoidal structure, cell wall 3 µm broad, not constricted, cross wall plane, cell 24.5 µm broad, 54-60 µm long, chloroplast parietal.

Odisha: Narayani, Khurda (29°C, pH- 6.8). Epilithic bluish green biofilm, 02.10.2008, V.N. - 1868; West Bengal: Gangamaya park, Darjeeling. Submerged filamentous mat attached to rock in stream; 10.09.2008, V.N. - 1767; Sikkim: Hanuman tok, Gangtok (18°C; pH - 6.8). Filamentous mat attached to rock, 12.09.2008, V.N. – 1782.

69. **Leptosira mediciana** Kant & Gupta; Kant & Gupta 1998, p. 113, pl. 43, fig. 4; pl. 107.fig. 46 **(Pl. 8, Fig. 7)**

Thallus branched, without hair, differentiated into prostrate and projecting systems, sporangia intercalary, terminal cells elliptical, doliform or irregular, apical cells of branches acutely attenuated, cells 10-27 µm long and 7.5-15 µm broad.

West Bengal: Chitrey, Kalimpong (29°C; pH - 6.8). Filamentous mat, 08.09.2008, V.N.– 1757; Sikkim: Kyongnosola (14°C, pH – 6). Bluish green patch attached to rock surface; 12.09.2008, V.N. – 1787.

70. ***Oedogonium chaetophorum** var. **chaetophorum** Hoff.; Gonzalves 1981, p. 568, fig. 515 A **(Pl. 8, Fig. 1)**

Thallus greenish, filamentous, vegetative cell cylindrical, 16 µm broad, plane cross wall, slightly constricted.

West Bengal: Chitrey, Kalimpong (29°C; pH - 6.8). Slimy epilithic biofilms, 08.09.2008, V.N.– 1755; Sikkim: Ranipool, Gangtok (20°C, pH - 6.7). Epilithic biofilm, 14.09.2008, V.N. – 1811.

71. **Oedogonium pisanum** (Wittrock) Hirn.; Gonzalves 1981, p. 342, fig. 9.228 **(Pl. 8, Fig. 2)**

Thallus green, filamentous, vegetative cells cylindric, 34-44 µm long, 12-14 µm broad, basal cell elongated, terminal cell piliferous, operculate.

West Bengal: Kalimpong (24°C, pH - 6.8). Epilithic mat in stream, 08.09.2008, V.N.– 1749; Sikkim: Hanuman tok, Gangtok (18°C; pH - 6.8). Greenish epilithic mat, 12.09.2008, V.N. – 1784.

72. **Oedogonium radhawae** Venk; Gonzalves 1981, P.238, fig. 9.117 **(Pl. 8, Fig. 3)**

Thallus greenish, filamentous, long, entangled, filament having holdfast, cap cell present, chloroplast parietal, cells longer than broad, 25-35 µm long, 10 µm broad, slightly capitates, basal cell reduced hemispherical.

Sikkim: Lachung. Blackish to grey epilithic biofilm, 14.06.2010, V.N. – 2539.

73. **Oedogonium tiffanyi** Ack.; Gonzalves 1981, p. 330, fig. 9.211 **(Pl. 3, Fig. 15)**

Thallus greenish, unbranched filamentous, macrandrous, cells longer than broad, 61.6µm long, 14 µm broad, oogonium globous, 28-31.5 µm in diameter, oospore filled oogonium, pores anterior-lateral.

Odisha: Sitakund, Mayurbhanj. Epilithic biofilm, 06.10.2008, V.N. – 2033; Odisha: Ghagra, Keonjhar. Bluish biofilm, 25.11.2008, V.N.- 2079.

76. **Oedogonium wyliei** Tiff.; Gonzalves 1981, p. 332, fig. 213 **(Pl. 8, Fig. 4)**

Thallus green, filamentous, unbranched, vegetative cell long and cylindrical, 52-54 µm long, 12-16 µm diameters, macrandrous.

Odisha: Sitakund, Mayurbhanj. Epilithic biofilm, 06.10.2008, V.N. – 2033; Odisha: Nrushinghanath, Baragarh. Bluish green epilithic biofilm; 18.09.2010; V.N.– 2668; West Bengal: Gangamaya park, Darjeeling (20°C). Floating filaments; 10.09.2008, V.N.– 1768; Sikkim: Hanuman tok, Gangtok (18°C; pH - 6.8). Greenish epilithic mat, 12.09.2008, V.N. – 1784.

77. *** Phycopeltis epiphyton** Millard; Ettl & Gärtner 1995, P. 595, fig. 201-b; Fritsch 1935, p. 278, figs. 86 A-E **(Pl. 8, Fig. 8)**

Thallus discoid, epiphytic, grayish green, multi cellular, colonial; three cells missed, thallus 40 µm wide, chordate in shape or irregular out line.

West Bengal: Ganga maya park, Darjeeling. Green filamentous mat; 10.09.2008, V.N.– 1768; Sikkim: Hanuman tok, Gangtok (18°C; pH - 6.8). Greenish epilithic mat, 12.09.2008, V.N. – 1784.

EUGLENOPHYTA

ORDER – EUGLENALES

1. **Euglena gracilis** Klebs; Wotowski & Hindák 2005, p. 31, fig. 142-145 **(Pl. 3, Fig. 17)**

Cells cylindrical or slightly spindle shaped, rounded anterior end, posterior end tapers to a blunt point, anterior end slightly truncated at the apex, chloroplast large, paramylon bodies small, numerous, cell 58 µm long and 9 µm broad.

Odisha: Huluhula, Ganjam. Epipsammic mat, 20.04.2008, V.N. – 1488.

2. **Phacus pleuronectes** (Ehrenb.) Dujardin; Wołowski & Hindák 2005, p. 36, fig. 204, 205; Basionym – *Cercaria pleuronectes* Müller; Synonym - *Cercaria pleuronectes* Müller, *Phacus granulatus* var. *laevis* Shi, *Phacus pleuronectes* var. *prunoideus* (Roll) Popova, *Phacus megapyrenoidea* Roll **(Pl. 3, Fig. 18)**

Cells broadly ovoid to sub orbicular in outline, slightly asymmetrical, 45.6 µm long and 28.2 µm broad, anterior end narrowly rounded and shallow bilobed, apical furrow up to half of cell length, slightly twisted, posterior end with slender cauda, turning obliquely to one side, dorsal keel from anterior end, pellicle longitudinally striated, chloroplasts parietal, numerous, disc-shaped, usually one large or two ring or disc shaped paramylon bodies.

Odisha: Nirmalajhara, Ganjam. Slimy epilithic biofilms, 17.05.2008, V.N.– 1503.

3. ***Trachelomonas bacilifera** Playfair var. **minima** Playfair; Wołowski & Hindák 2005, p. 45, fig. 317, 363, 364 **(Pl. 3, Fig. 19)**

Lorica oval in shape, reddish wall, covered with blunt rod like spines, apical pore without collar, due to lorica structure, chloroplast indistinct, cells 20.8 µm long and 17.6 µm broad.

Odisha: Phurlijharan, Kalahandi (20°C, pH-6.2). Attached to submerged rock surface, 23.03.2009, V.N.- 2382.

HETEROKONTOPHYTA

1. **Cyclotella meneghiniana** Kütz.; Kützing 1865, p. 50, pl. 30, fig. 68 **(Pl. 4, Fig. 1)**

Frustules discoid in valve view, rectangular and undulated in girdle view, margin well defined, coarsely striated and striae wedge shaped, 8-10 in 10 µm, diameter is 10.7 µm.

Odisha: Devkund, Mayurbhanj. Benthic, Epilithic in stream, 06.01.2011, V.N.– 4521, 4523; Odisha: Huluhula, Ganjam. Epipsammic mat, 20.04.2008, V.N. – 1488.

2. ***Melosira varians** var. **aequalis** Kütz.; Kützing 1865, p. 54, pl. 2, fig. XI- 1 **(Pl. 8, Fig. 9)**

Cells cylindrical, united end to end forming a long chain, margin smooth, plastids parietal, cell 23.5 µm long and 22 µm broad, little square shaped.

West Bengal: Rock garden, Darjeeling (20°C, pH - 6.8). Epilithic biofilms, 10.09.2008, V.N. – 1777; Sikkim: Ranipool, Gangtok (20°C, pH - 6.7). Epilithic biofilm, 14.09.2008, V.N. – 1806.

3. **Fragillaria virescens** Ralfs.; Ettl & Gärtner 1995, p. 42, fig. 8 m **(Pl. 8, Fig. 10)**

Valves united laterally, girdle view rectangular, linear, striation transverse, marginal, 11 in 10 µm, valve 11 µm broad, 82.5 µm long.

Odisha: Devkund, Mayurbhanj. Benthic, 06.01.2011, V.N.– 4525; Odisha: Panchalingeswar. Epilithic biofilms, 02.10.2008, V.N.– 4618; Odisha: Ghagra, Keonjhar. Brownish biofilm, 25.11.2008, V.N.- 2070; Odisha: Sitakund, Mayurbhanj. Epilithic biofilm, 06.10.2008, V.N. – 2033; West Bengal: Chitrey, Kalimpong (29°C; pH - 6.8). Epilithic biofilm, 08.09.2008, V.N.– 1751; Sikkim: Ranipool, Gangtok (20°C, pH - 6.7). Epilithic biofilm, 14.09.2008, V.N. – 1806.

4. **Synedra affinis** Kütz; Kützing 1865, p.68, pl. 15, fig. XI **(Pl. 8, Fig. 11)**

Valve linear, solitary or grouped together with mucilaginous base, valve rectangular in girdle view, narrow lanceolate, striation parallel, frustules 20 µm long, 4.5 µm broad.

Sikkim: Chungthang. Green filamentous mat, 17.06.2010, V.N. – 2563.

5. **Synedra gallionii** Kütz.; Kützing 1865, p.68, pl. 30, fig. 42 **(Pl. 8, Fig. 12)**

Valve solitary, linear, narrow, lanceolated, both end slightly produced, striation transverse, parallel, raphe medium, cells 80 µm long, 6,5 µm broad.

Sikkim: Chungthang. Epilithic biofilm, 15.06.2010, V.N. – 2551.

6. **Synedra tergestina** Kütz.; Kützing 1865, p. 66, pl. 4, fig. XXXIII **(Pl. 4, Fig. 3)**

Valve linear, long, 112.5 µm long, 10 µm broad, both ends slightly bent outwards, valve somehow rectangular, striation transverse, parallel, striae 9 in 10 µm.

Odisha: Huluhula, Ganjam. Planktonic, 17.05.2008, V.N. – 1513; Odisha: Panchalingeswar. Epilithic biofilms, 02.10.2008, V.N.– 4614; Odisha: Ghagra, Keonjhar. Brownish biofilm, 25.11.2008, V.N.- 2070.

7. **Synedra ulna** (Nitzsch) Ehrenb.; Ettl & Gärtner 1995, p. 43, fig. 9 b; Synonym- *Fragilaria ulna* (NItzsch) Lange- Bertalot **(Pl. 8, Fig. 13)**

Valve long, 342 µm long, 9.2 µm broad, solitary, linear, parallel margin, attenuated rounded end, indistinct central area, isopolar, transverse striation.

Odisha: Panchalingeswar. Epilithic biofilms, 02.10.2008, V.N.– 4610; Odisha: Ghagra, Keonjhar. Brownish biofilm, 25.11.2008, V.N.- 2070; Odisha: Huluhula, Ganjam. Planktonic, 17.05.2008, V.N. – 1513; West Bengal: Chitrey, Kalimpong (29°C; pH - 6.8). Epilithic biofilm, 08.09.2008, V.N.– 1751.

8. **Synedra ulna** (Nitzsch) Ehrenb. var. *aequalis* (Kütz.) Hustedt.; Huber – Pestalozii 1942, p. 461, pl. CXXXV, fig. 542; Synonym- *Synedra aequalis* Kütz.; *Synedra obtuse* Wm. Smith **(Pl. 8, Fig. 14)**

Frustules linear, straight, slender, at the end narrow and slightly constricted to form an obtuse end, many times longer than broad, 50 - 90 µm long and 8 -12 µm broad; striation distinct and parallel, striae 9 -12 in 10 µm.

Odisha: Harishankar, Balangir (pH - 6.7). Brownish epilithic biofilm, 27.07.2008, V.N.– 1646; Odisha: Devkund, Mayurbhanj. Epilithic abd Benthic in stream, 06.01.2011, V.N.– 4518, 4524; Odisha: Ghagra, Keonjhar. Brownish biofilm, 25.11.2008, V.N.- 2070; Mizoram: Phunchawang. Epilithic biofilms, 24.03.2008, V.N.- 1425; Sikkim: Lachung. Blackish to grey epilithic biofilm, 14.06.2010, V.N. – 2537.

15. **Synedra ulna** (Nitzsch) Ehrenb. var. **amphirhynchus** (Ehr.) Grun.; Huber-Pestalozii 1942, p. 462, fig. 545; Synonym – *Synedra amphirhynchus* Ehrenb. **(Pl. 8, Fig. 15)**

Valve slender, linear, straight, at the end narrow and suddenly constricted to form capitate end, striation distinct, parallel, absent at the middle, 9-12 in 10 µm, many times longer than broad, 114 µm long and 13.3 µm broad.

Odisha: Harishankar, Balangir (pH - 6.7). Brownish epilithic biofilm, 27.07.2008, V.N.– 1646; Sikkim: Lachung. Blackish to grey epilithic biofilm, 14.06.2010, V.N. – 2539.

16. **Synedra ulna** (Nitzsch) Ehrenb. var. **oxyrhynchus** (Kütz.) Van Heurck; Huber-Pestalozii 1942, p. 461, fig. 542; Synonym – *Synedra oxyrhynchus* Kütz. **(Pl. 8, Fig. 16)**

Valve linear to slightly lanceolate, long, straight, end narrow, roundly capitate, striation parallel throughout the valve, slightly radiate at the apices, striae 10-14 in 10 µm area, many times longer than broad, 85.8 – 155.6 µm long and 8 – 12.6 µm broad.

Odisha: Sitakund, Mayurbhanj. Epilithic biofilm, 06.10.2008, V.N. – 2040; Date of collection- 06.10.2008; Sikkim: Chungthang. Epilithic biofilm, 15.06.2010, V.N. – 2551.

17. **Fragillaria virescens** Ralfs; Ettl & Gärtner 1995, p. 42, fig. 8 m **(Pl. 8, Fig. 10)**

Valves united laterally, girdle view rectangular, linear, striation transverse, marginal, 11 in 10 µm, valve 4.5-6.5 µm broad, 50-55 µm long.

Sikkim: Lachung. Blackish to grey epilithic biofilm, 14.06.2010, V.N. – 2538.

Genus- Diatoma Bory de St-Vinent

18. ***Diatoma pectinale** Kütz.; Kützing 1865, p. 45, pl. 17, fig. 9-1 **(Pl. 4, Fig. 8)**

Frustules in a chain, rectangular in girdle view, regular, longer than broad, 6.7 µm broad, 12.5 µm long.

Odisha: Dharakote, Ganjam (34°C, pH- 7.5, Conductivity- 272µs, Transparency 3ft). Floating mat, 17.05.2008, V.N.-1513. Odisha: Nirmalajhara, Ganjam. Slimy epilithic biofilms, 17.05.2008, V.N.– 1503.

19. **Diatoma mesodon** f. **quadratum** Kütz.; Kützing 1865, p. 47, pl. 30, fig. 78 **(Pl. 8, Fig. 17)**

Frustule rectangular in girdle view, keels punctuate, costae thick, cell 25 µm long, 17.5 µm broad.

Sikkim: Chungthang. Blackish to grey epilithic biofilm, 15.06.2010, V.N. – 2557.

20. **Grammatophora undulata** Kütz.; Kützing 1865, p. 129, pl. 29, fig. 68 **(Pl. 8, Fig. 36)**

Frustule solitary, linear, rectangular in girdle view, raphe median, striation indistinct, cell 19 µm long, 10 µm broad.

Sikkim: Lachung. Blackish to grey epilithic biofilm, 14.06.2010, V.N. – 2531.

21. **Achnanthes coarctata** var. **parallela** G.S. Venkataraman; Kant & Gupta 1998, p. 150, pl. 128, fig. 6 **(Pl. 4, Fig. 9)**

Valves linear with broad, rounded ends, margin almost parallel in the middle, raphe straight, axial area broad, reaching the margins, striae 8 - 10 in 10 µm, clearly punctate and radial on the raphe valve, 44 - 52 µm long and 10.6 – 12.4 µm broad.

Odisha: Sitakund, Mayurbhanj. Epilithic in stream, 06.10.2008, V.N. - 2034.

22. **Achnanthes inflata** (Kuetz) Grun.; Prasad & Srivastava 1992, P. 195, Pl.27, Fig. 4&5; Jena & al., 2006. P. 384, Pl.1, Fig. 22 **(Pl. 4, Fig. 10)**

Frustule solitary, gelatinous, united in bundles forming ribbon like colonies, in girdle view curved longitudinally particularly at the centre. Median raphe with distinct central and polar nodules, striation transverse, 11 in 10 µm, frustule 52 µm long, 18-20 µm broad.

Odisha: Narayani, Khurda (29°C, pH- 6.8). Green epilithic mat, 02.10.2008, V.N.- 1875.

23. **Achnanthes subsessilis** Kütz.; Kützing 1865, p. 76, pl. 20, fig. IV; Synonym- *Achnanthes turgens* Ehrenb. **(Pl. 8, Fig. 20)**

Valve rectangular, slightly hump at middle, 2 valves articulated, turgid, 36 µm long and 10.8 µm broad; striation distinct, marginal, transverse, 10-11 in 10 µm.

West Bengal: Gangamaya park, Darjeeling (20°C). Epilithic biofilms, 10.09.2008, V.N.- 1768; Sikkim: Hanumantok, Gantok (18°C, pH - 6.8). Epilithic biofilm, 12.09. 2008, V.N.– 1780.

24. **Cocconeis pediculus** Ehrenb.; Kützing 1865, p.71, pl. 5, fig. IX (1) **(Pl. 8, Fig. 18)**

Frustules subcircular or broadly elliptical, with marginal bend, lanceolate outline, rounded end, 20-27µm long and 10-17 µm broad; striation not visible in fresh material.

Odisha: Barunei, Khurda. V.N.- Epilithic biofilm in the stream, 17.05.2008, 1492; Odisha: Panchalingeswar. Epilithic biofilms, 02.10.2008, V.N.– 4611; Mizoram: Phunchawang. Epilithic biofilms, 24.03.2008, V.N.- 1425.

25. **Diploneis puella** Schum.; Pascher 1913, p. 67, fig. 121; Basionym – *Navicula puella* Schumann; Synonym - *Navicula puella* Schumann, *Navicula elliptica* var. *puella* (Schumann) Peragallo **(Pl. 4, Fig. 12)**

Valve small, solitary, linear, broadly lanceolate or elliptical, ends broadly rounded; indistinct raphe and striae, valve 8 µm broad and 16 µm long.

Odisha: Ghagra, Keonjhar. Brownish biofilm, 25.11.2008, V.N.- 2070; Odisha: Narayani, Khurda (29°C, pH- 6.8). Green epilithic mat, 02.10.2008, V.N.- 1866.

26. **Diploneis subovalis** Cleve; Gonzalves & Gandhi, 1953, p. 254, fig. 87 **(Pl. 8, Fig. 19)**

Valves broadly elliptical, with rounded ends, central nodule present, furrows narrow, 64.3 µm long and 41.4 µm broad, costae strong, alternating with double rows of alveoli.

Nagaland: Pherem, Epilithic, 18.02.2011, V.N.– 3028.

27. **Diadesmis confervacea** Kütz. Kützing 1865, p. 109, pl. 30, fig. 8 a, b; Synonym – *Diadesmis confervaceoides* Lange-Bertalot & Rumrich **(Pl. 4, Fig. 13)**

Valve attached side by side to form ribbon shaped colony, filamentous, gelatinous, rectangular in girdle view, end truncate flated, gap between the valves at the middle, longer than broad, 11 µm long and 5-6.6 µm broad.

Odisha: Harishankar, Balangir (pH - 6.7). Brownish epilithic biofilm, 27.07.2008, V.N.– 1646; Odisha: Panchalingeswar. Epilithic biofilms, 02.10.2008, V.N.– 4613.

28. ***Stauroneis birostris** Ehrenb.; Kützing 1865, p. 105, pl. 29, fig. 9 **(Pl. 8, Fig. 21)**

Valve solitary, linear, lanceolate, broader at middle, tapered towards ends or rostrate at both ends, valve 36 µm long and 9 µm broad, sub-acutely rounded ends, raphe thin, striation not distinct.

West Bengal: Chitrey, Kalimpong (29°C; pH - 6.8). Epilithic biofilm, 08.09.2008, V.N.– 1751; Sikkim: Ranipool, Gangtok (20°C, pH - 6.7). Epiphytic, 14.09.2008, V.N. – 1808.

29. **Pinnularia acrosphaeria** (Breb.) W. Smith f. **undulata** Cleve; Prasad and Srivastava 1992, p. 229, pl. 30, fig. 10 **(Pl. 4, Fig. 14)**

Valve solitary, linear, inflation in middle and towards ends, 56µm long and 1.5µm broad at middle, apices broadly rounded, raphe thick, distinct central nodule.

Odisha: Huluhula, Ganjam. Epipsammic mat, 20.04.2008, V.N. – 1488; Odisha: Barunei, Khurda. V.N.- Epilithic biofilm in the stream, 17.05.2008, 1492.

30. **Navicula borealis** Kütz.; Kützing 1865, p. 96, pl. 28, fig. 72; Basionym – *Pinnularia borealis* Ehrenb. **(Pl. 8, Fig. 22)**

Valve linear, lanceolate, solitary, parallel at middle and gradually tapering towards end, apices acutely rounded, striation transverse, single median raphe, chromatophore single, valve 25 μm long and 6 μm broad.

West Bengal: Chitrey, Kalimpong (29°C; pH - 6.8). Epilithic biofilm, 08.09.2008, V.N.– 1751; Sikkim: Ranipool, Gangtok (20°C, pH - 6.7). Epiphytic, 14.09.2008, V.N. – 1808.

31. **Navicula exigua** (Gregory) Grun.; Ettl & Gärtner 1995, p. 64, fig. 12 K **(Pl. 4, Fig. 15)**

Valve broadly lanceolate with narrow rostrate rounded ends, thin straight raphe with central pores, valve 39.2 μm long and 11.5 μm broad

Odisha: Nirmalajhara, Ganjam. Slimy epilithic biofilms, 17.05.2008, V.N.– 1506.

32. **Navicula gracilis** Kütz.; Kützing 1865, P. 91, Pl. 3, Fig. XLVIII **(Pl. 8, Fig. 23)**

Frustule solitary, linear, lanceolated, raphe median, striation transeverse, cells 33 μm long, 6 μm broad.

Sikkim: Chungthang. Epilithic biofilm, 15.06.2010, V.N. – 2553.

33. **Navicula lanceolata** Kütz.; Kützing 1865, P. 94, Pl. 28, Fig. 38 **(Pl. 8, Fig. 24)**

Frustule solitary, linear, lanceolated with truncated ends, striation and raphe indistinct, cell 35 μm long, 5 μm broad.

Sikkim: Chungthang. Epilithic biofilm, 15.06.2010, 17.06.2010, V.N.– 2537, 2551.

34. ***Navicula lunata** Kütz.; Kützing 1865; P. 39, Pl. 16, Fig. X (1-4) **(Pl. 4, Fig. 16)**

Frustule solitary, linear, rectangular in girdle view, indistinct raphe and striation, valve view lunate or concave at middle with rounded at both end, valve 6.5 μm broad and 25-37 μm long.

Odisha: Nirmalajhara, Ganjam. Slimy epilithic biofilms, 17.05.2008, V.N.– 1504; Odisha: Panchalingeswar. Epilithic biofilms, 02.10.2008, V.N.– 4613; Odisha: Nrushinghanath, Baragarh. Brownish epilithic biofilm in the stream; 18.09.2010; V.N.– 2670.

35. **Navicula sphaerophora** Kütz.; Kützing 1865, p. 95, pl. 4, fig. XVII **(Pl. 8, Fig. 25)**

Valve broadly lanceolate or elliptical with produced end, apices acutely rounded, striation not clearly visible; valve 17.7 μm long and 7.7 μm broad.

West Bengal: Chitrey, Kalimpong (29°C; pH - 6.8). Epilithic biofilm, 08.09.2008, V.N.– 1757; Sikkim: Ranipool, Gangtok (20°C, pH - 6.7). Green filamentous mat, 14.09.2008, V.N. – 1809.

36. **Navicula viridis** Kütz.; Kützing 1865, p. 97, pl. 4, fig. XVIII **(Pl. 8, Fig. 26)**

Frustules linear oblong, rectangular in valve view, slightly attenuated towards the apex, apices rotundatus, striation transverse, striae 8-12 in 10 μm area, 58.3 - 98 μm long and 14.8 – 18.2 μm broad.

Nagaland: Pherem, Epilithic, 18.02.2011, V.N.– 3028.

37. **Navicula viridula** Kütz.; Kützing 1865, P.91, pl. 3, fig. XLIV**;** Synonym- *Frustulia viridula* Kütz. **(Pl. 8, Fig. 27)**

Frustules linear lanceolate, elongated, attenuated towards apices to obtuse end, 40-45 μm long and 5-12 μm broad; raphae not clear; striation clearly visible in fresh material.

Mizoram: Phunchawng. Epilithic, 24.03.2008, V.N.- 1425; Sikkim: Chungthang. Epilithic Biofilm, 15.06.2010, V.N.– 2553.

38. **Gomphonema abbreviatum** Kütz.; Kützing 1865, p. 84, pl. 8, fig. V **(Pl. 8, Fig. 28)**

Frustules linear, paired, rectangular in girdle view, raphe median, striation parallel, 8-10 in 10 µm,27.5 µm long and 5 µm broad.

Sikkim: Lachung. Blackish to grey epilithic biofilm, 14.06.2010, V.N. – 2535.

39. **Gomphonema constrictum** Ehrenb. var. **capitatum** (Ehrenb.) Grun.; Mishra 2008, p. 129, pl. 2, fig. 12 **(Pl. 8, Fig. 29)**

Valve linear, lanceolate to clavate, broadly rounded apex, attenuated rounded base, thin median raphe, without transverse constriction, axial area linear, narrow, gradually widening towards centre, striation transverse, thick, lineate or slightly curved, frustule 12 µm broad and 40 µm long, striae 10 in 10 µm.

West Bengal: Chitrey, Kalimpong (29°C; pH - 6.8). Epilithic biofilm, 08.09.2008, V.N.– 1751; Sikkim: Ranipool, Gangtok (20°C, pH - 6.7). Epiphytic, 14.09.2008, V.N. – 1808.

40. **Gomphonema elegans** var. **robusta** Kant & Gupta; Kant & Gupta 1998, pl. 125, fig. 1 **(Pl. 8, Fig. 30)**

Valve lanceolate, central portion constricted at both ends from inside, striae marginal, length of valve 30-33 µm and breadth 4-7 µm.

Mizoram: Phunchawang. Epilithic biofilms, 24.03.2008, V.N.- 1425.

41. **Gomphonema exiguum** Kütz.; Kützing 1865, p. 84, pl. 30, fig. 58 **(Pl. 8, Fig. 31)**

Valve linear, colonial, small, longitudinally symmetrical, base of the valve attached with mucilaginous stalk, striation transverse, raphe present on both the valve, one plane broader than the other, valve 25 µm long and 7 µm broad, striae 11 in 10 µm.

West Bengal: Chitrey, Kalimpong (29°C; pH - 6.8). Epilithic biofilm, 08.09.2008, V.N. – 1757; Sikkim: Ranipool, Gangtok (20°C, pH - 6.7). Epilithic biofilm, 14.09.2008, V.N. – 1805.

42. **Gomphonema micropus** Kütz.; Kützing 1865, p. 84, pl. 8, fig. XII **(Pl. 4, Fig. 17)**

Frustules small, linear, cuneate, asymmetrical, end truncate base obtuse, striation marginal, parallel, 8-10 in 10 µm, 31.5 µm long, 3.6-7.8 µm broad.

Odisha: Panchalingeswar. Epilithic biofilms, 02.10.2008, V.N.– 4613; Odisha: Nrushinghanath, Baragarh. Epilithic biofilm; 18.09.2010; V.N.– 2656.

43. ***Gomphonema minutissimum** Grev.; Kützing 1865, p. 84, pl. 8, fig. XI **(Pl. 8, Fig. 32)**

Valves colonial, attached at their bases with mucilaginous stalk; cells linear, narrower at base, slightly broader at apex or some how rectangular, indistinct striation, cells 25 µm long and 4.5 µm broad

Sikkim: Pastanga (20°C, pH - 6.7). Epilithic biofilm, 10.09.2008, V.N. – 1806.

44. **Gomphonema montanum** Schum. var. **genuinum** Mayer; Pal & Santra 1990, p. 75, pl. 1, fig. 15 **(Pl. 4, Fig. 18)**

Frustules slightly clavate with rounded poles, central area broad, one side normal, other side attenuated, 41.8 - 61.7 µm long and 10.5 - 14.2 µm broad, striation distinct, transverse, convergent towards the base, 5 – 8 in 10 µm area.

Odisha: Nirmalajhara, Ganjam. Slimy epilithic biofilms, 17.05.2008, V.N.– 1506.

45. **Gomphonema olivaceum** (Lyng.) Kütz.; Kützing 1865, p. 85, pl. 7, fig. XIII, XV; Basionym – *Ulva olivacea* Hormemann; Synonym – *Gomphonema olivacea* (Hornemann) Dawson ex Ross & Sims **(Pl. 8, Fig. 33)**

Frustules lanceolate clavate with broad, rounded apices and attenuated base, middle wide, striation coarse and distinct, parallel, 8-10 in 10 µm,33 µm long and 10 µm broad.

Sikkim: Chungthang. Submerged filamentous mat, 17.06.2010, V.N.– 2563.

46. **Gomphonema parvulum** (Kütz.) Grun. var. *micropus* (Kütz.) Cleve; Prasad & Srivastava 1992, p. 256, pl. 33, fig. 17 **(Pl. 4, Fig. 19)**

Valves clavate-lanceolate with slightly constricted, acutely rounded apex, raphe thin, straight, median, terminal fissures slightly curved, axial area linear lanceolate, central area broad, unilateral with an isolated puncta, opposite side striae thin, lineate, radiate, short and distantly placed in the middle but comparatively dense towards apices, 38 - 48 µm long and 10.4 - 14 µm broad.

Odisha: Panchalingeswar. Epilithic biofilms, 02.10.2008, V.N.– 4614.

47. **Gomphonema telegraphicum** Kütz.; Kützing 1865, p. 84, pl. 8, fig. IX **(Pl. 8, Fig. 34)**

Frustules lanceolate, clavate with broad, rounded apices and attenuated base, middle wide, striation coarse and distinct, parallel, 8-10 in 10 µm,32 µm long and 9 µm broad.

Sikkim: Lachung. Blackish to grey epilithic biofilm, 14.06.2010, V.N. – 2535.

48. **Cymbella affinis** Kütz.; Kützing 1865, p. 80, pl. 6, fig. XV; Synonym – *Cymbella excisa* Kütz. **(Pl. 4, Fig. 20)**

Frustules biraphid, asymmetrical, elliptic, oblong, end obtuse, dorsal side convex, ventral margin slightly gibbous, raphe arcuate or towards the ventral margin, striation distinct, transverse, parallel, striae 9 - 10 in 10 µm, longer than broad, 49 - 56 µm long and 11.8 - 13 µm broad.

Odisha: Phurlijharan, Kalahandi (20°C, pH-6.2). Brownish biofilm on rock surface, 23.03.2009, V.N.- 2390.

49. **Cymbella tumida** (Bréb.) Van Heurck; Kant & Gupta 1998, p. 163, pl. 72, fig. 13; Basionym – *Cocconema tumidum* Brébisson; Synonym - *Cocconema tumidum* Brébisson **(Pl. 8, Fig. 35)**

Valve broadly lanceolate, dorsal and ventral margins bent in opposite directions, end obtuse, dorsally constricted, valve 17 µm broad and 42.6 µm long.

Odisha: Pradhanpat, Deogarh (pH- 7.2). Epilithic on rock surface; 28.07.2008, V.N.– 1654; Odisha: Harishankar, Balangir (pH - 6.7). Brownish epilithic biofilm, 27.07.2008, V.N.– 1646; Odisha: Barunei, Khurda. V.N.- Epilithic biofilm in the stream, 17.05.2008, 1492; Odisha: Devkund, Mayurbhanj. Epilithic and Benthic, 06.01.2011, V.N.– 4518, 4523, 4524; West Bengal: Chitrey, Kalimpong (29°C; pH - 6.8). Epilithic biofilm, 08.09.2008, V.N.– 1751.

50. **Eunotia amphioxys** Ehrenb.; Kützing 1865, p.36, pl. 29, fig. 44; pl. 30, fig. 1 **(Pl. 4, Fig. 22)**

Valve solitary, girdle view rectangular, valve view asymmetrical to longitudinal axis, dorsal margin more or less convex, ventral margin slightly concave; valve 20-26 µm long and 5-6.5 µm broad.

Odisha: Harishankar, Balangir (pH - 6.7). Bluish green epilithic mass under flowing water, 27.07.2008, V.N.– 1647.

51. **Licmophora abreviata** C. Agardh; Jena *& al.* 2005, p. 73, pl. 3, fig. 16 **(Pl. 4, Fig. 23)**

Valve linear, solitary, longitudinally symmetrical, base narrower than apices, striation transverse, valve 25 µm long, 6.5 µm broad.

Odisha: Barunei, Khurda. V.N.- Epilithic biofilm in the stream, 17.05.2008, 1495.

52. **Himantidium minus** Kütz.; Kützing 1865, p. 39, pl. 16, fig. X (1-4) **(Pl. 4, Fig. 25)**

Frustule in girdle view linear, rectangular, parallel sides attached side by side to form ribbon shaped filament, frustules longer than broad, 15-17 µm long and 5-7 µm broad, striation indistinct.

Odisha: Nirmalajhara, Ganjam. Slimy epilithic biofilms, 17.05.2008, V.N.– 1503.

53. **Amphora veneta** Kütz.; Sinha 2002, p. 65, pl. 2, figs. 1-4 **(Pl. 4, Fig. 24)**

Frustules elliptical with rounded ends, margins medianly constricted; raphe thin, linear, striae lineate, 26 µm long, 11 µm broad.

Odisha: Barunei, Khurda. V.N.- Epilithic biofilm in the stream, 17.05.2008, 1492.

54. **Nitzschia closterium** (Ehrenb.) W. Smith; Prasad and Srivastava 1992, p. 289, pl. 35, fig. 4 **(Pl. 4, Fig. 27)**

Valve 60µm long, 5.5µm broad at middle, spindle shaped at middle and obliquely curved in a sickle shaped narrowly produced rounded ends, indistinct striation.

Odisha: Huluhula, Ganjam. Epipsammic mat, 20.04.2008, V.N. – 1488.

55. **Nitzschia sigmoidea** (Nitzsch) W. Smith; Desikachary 1989, p. 4, pl. 663, fig. 3; Basionym – *Bacillaria sigmoidea* Nitzsch; Synonym - *Bacillaria sigmoidea* Nitzsch, *Nitzschia elongata* Hassal **(Pl. 4, Fig. 26)**

Frustules linear, sigmoid with rounded ends, raphe thin, central, 85.8 µm long and 8 µm broad, striae fine, dense, lineate and paralle throughout the valve, 10 -12 in 10 µm area.

Odisha: Narayani, Khurda (29°C, pH- 6.8). Epilithic biofilm, 02.10.2008, V.N.- 1875.

56. ***Nitzschia sinuata** var. **tabellaria** Grun.; Wehr and Sheath 2003, P. 677, fig. 20 **(Pl. 8, Fig. 37)**

Frustules with curved septa, fusiform, the poles narrowed from an enlarged central region, length 17-20 µm and breadth 7-8 µm.

Mizoram: Sairang. Epilithic biofilms, 24.03.2008, V.N.- 1426.

57. **Nitzschia vasnii** H.P. Gandhi; Kant & Gupta 1998, p. 166, pl. 71, fig. 1; pl. 121, fig. 8; pl. 129, fig. 11 **(Pl. 4, Fig. 28)**

Valve linear, lanceolate, valve margin almost parallel with cuneate ends, valve 35 µm long and 6 µm broad.

Odisha: Panchalingeswar. Epilithic biofilms, 02.10.2008, V.N.– 4614, Odisha: Nrushinghanath, Baragarh. Epilithic biofilms, 18.09.2010, V.N.– 2656; Odisha: Huluhula, Ganjam. Epipsammic mat, 20.04.2008, V.N. – 1488.

58. **Epithemia gibberula** var. **producta** Grun.; Prasad & Srivastava, 1992, p. 278, pl. 32, fig. 10 **(Pl. 8, Fig. 39)**

Frustules broadly elliptical, with sub truncate ends, dorsal margin arcuate, ventral margin with a slight curvature, end rostrate, costae distinct, radiate, slightly dilated below the apices, 33.6 – 47.7 µm long and 23.2 – 27.7 µm broad, striae fine, 2 – 8 in two consecutive costae.

Nagaland: Pherem, Planktonic, 18.02.2011, V.N.– 3028.

59. **Epithemia turgidula** Kütz.; Kützing 1865, p. 34, pl. 5, fig. XIV, 3; Basionym – *Navicula turgida* Ehrenb.; Synonym - *Cymbella turgida* (Ehrenb.) Hassal, *Cystopleura turgida* (Ehrenb.) Kuntze **(Pl. 8, Fig. 40)**

Frustules in pairs, linear, girdle view rectangular, valve view elliptical, convex at dorsal side, axial field close to the convex side of valve, truncated towards apices, apices obtuse, striation distinct, transverse, divergent, striae 10 - 12 in 10 µm, longer than broad, 40 µm long, 13 µm broad.

Sikkim: Lachung. Blackish to grey epilithic biofilm, 14.06.2010, V.N. – 2539.

60. ***Sphenella angustata** Kütz.; Kützing1865, p. 83, pl. 8, fig. IV **(Pl. 8, Fig. 38)**

Valve linear, slightly attenuated towards end or almost rectangular, colonial, laterally attached, frustule 21.5 µm long and 33.5 µm broad, indistinct striations.

West Bengal: Chitrey, Kalimpong (29°C; pH - 6.8). Epilithic biofilm, 08.09.2008, V.N.– 1753; Sikkim: Ranipool, Gangtok (20°C, pH - 6.7). Epilithic biofilm, 14.09.2008, V.N. – 1805.

61. ***Surirella euglepta** Ehrenb.; Kützing 1865, p. 62, pl. 28, fig. 19 b **(Pl. 4, Fig. 29)**

Valve solitary, linear, elongated, rectangular in girdle view, 70.5µm long, 22.5-29µm broad, margin with distinct folds, costae thick, strong, costae 8 in10µm.

Odisha: Huluhula, Ganjam. Epipsammic mat, 20.04.2008, V.N. – 1488.

Table 2 : Algal taxa recorded from the streams of Odisha: 1- Panchalingeswar, 2- Devkund, 3- Sitakund, 4- Ghagara, 5- Pradhanpat, 6- Harishankar, 7- Nrushinghanath, 8- Phurlijharan, 9- Barunei, 10- Nirmalajhara, 11- Narayani, 12- Rushikullya stream at Huluhula.

Sl. No.	Algal taxa	Stream											
		1	2	3	4	5	6	7	8	9	10	11	12
1	**Cyanophyta (Cyanoprokaryota/ Cyanobacteria)** *Merismopedia glauca*	-	-	-	-	-	-	-	+	-	-	-	+
2	*Chroococcus dispersus*	-	-	+	-	-	-	-	-	-	-	-	-
3	*Chroococcus prescottii*	-	-	-	-	-	+	-	-	-	-	-	-
4	*Cyanosarcina Fontana*	-	-	-	-	-	+	-	-	-	-	-	-
5	*Geitleribactron periphyticum*	-	-	-	-	-	-	-	+	-	-	-	-
6	*Chroococcidiopsis fissurarum*	-	-	-	-	-	+	-	-	-	-	-	-
7	*Pleurocapsa concharum*	-	-	-	-	-	+	-	-	-	-	-	-
8	*Geitlerinema acutissimum*	-	-	-	-	-	-	-	+	-	-	-	-
9	*Spirulina major*	-	-	-	-	-	-	-	-	-	-	-	+
10	*Spirulina subsalsa*	-	-	-	-	-	-	-	-	-	-	-	+
11	*Homoeothrix culiana*	-	-	-	-	-	-	-	+	-	-	-	-
12	*Homoeothrix poljanskii*	-	-	-	-	-	-	-	+	-	-	-	-
13	*Trichocoleus erectiusculus*	-	-	-	-	-	-	-	-	-	-	+	-
14	*Phormidium autumnale*	-	+	-	-	-	-	-	-	-	+	+	-
15	*Phormidium granulatum*	-	-	-	-	-	-	-	-	-	-	+	-
16	*Phormidium koprophilum*	-	+	-	-	-	-	-	-	-	-	-	+
17	*Phormidium puteale*	-	-	-	-	+	+	-	-	-	-	-	-
18	*Phormidium terebriforme*	-	-	-	-	-	+	-	-	-	-	-	+
19	*Phormidium tergestinum*	-	-	-	+	-	-	-	-	-	-	-	+
20	*Oscillatoria acuta*	-	-	-	-	-	-	-	-	-	-	+	-
21	*Osillatoria agardhii*	+	-	-	-	-	-	-	-	+	-	+	-
22	*Oscillatoria limosa*	-	+	-	-	-	-	-	-	-	-	-	-
23	*Lyngbya hieronmusii*	-	-	-	-	-	+	-	-	-	-	-	-
24	*Lyngbya majuscule*	-	-	-	+	+	-	-	-	-	-	-	+
25	*Lyngbya sordia*	-	-	-	-	+	-	-	-	-	-	-	-
26	*Lyngbya splendens*	-	-	+	-	-	-	-	-	-	-	-	-
27	*Scytonema saleyeriense* var. *indica*	-	-	+	+	-	-	-	-	-	-	-	-
28	*Calothrix fusca*	-	-	-	-	+	+	-	-	-	-	-	-
29	*Dichothrix orsiniana*	+	-	+	-	-	-	-	-	-	-	-	-
30	*Rivularia mesenterica*	-	-	-	-	+	+	-	-	-	-	-	-
31	*Tolypothrix robusta*	-	-	-	-	+	-	-	-	-	-	-	-
32	*Anabaena affinis*	-	-	-	-	-	-	-	-	-	-	-	+
33	*Anabaena constricta*	-	-	-	-	-	-	+	-	-	-	-	+
34	*Aulosira bombayensis*	-	-	-	-	+	+	-	-	-	-	-	-
35	*Nostoc commune*	-	-	-	-	+	-	-	-	-	-	-	-
1	**Chlorophyta** *Spirogyra maravillosa*	-	-	-	+	-	-	+	-	-	-	+	-
2	*Spirogyra pseudoreticulata*	-	-	+	+	-	+	-	-	-	-	-	-

Sl. No.	Algal taxa	Stream											
		1	2	3	4	5	6	7	8	9	10	11	12
3	*Spirogyra rhizoids*	-	-	-	-	-	-	-	+	-	-	-	-
4	*Rhizoclonium hieroglyphicum*	-	-	-	-	-	-	-	-	-	-	+	-
5	*Rhizoclonium pachydermum*	-	-	-	-	+	-	-	-	-	-	-	-
6	*Sirocladium kumaoense*	-	-	-	-	+	-	-	-	-	-	-	-
7	*Gonatozygon kinahani*	+	-	-	+	-	-	-	-	-	-	-	-
8	*Cylindrocystis brebisonii*	-	-	-	-	-	-	+	-	-	-	-	+
9	*Cylindrocystis crassa*	-	-	-	-	-	-	-	-	-	-	-	+
10	*Cylindrocystis obesa*	-	-	-	+	-	-	-	-	-	-	-	-
11	*Netrium digitus*	-	-	-	-	-	-	+	-	-	+	-	-
12	*Penium navicula*	-	-	-	-	-	-	-	+	-	+	-	-
13	*Penium margaritaceum*	-	-	-	-	-	-	-	+	-	-	-	-
14	*Closterium acerosum*	-	-	-	+	-	-	-	-	-	-	-	+
15	*Closterium calosporum*	-	-	-	-	+	+	-	-	-	-	-	-
16	*Euastrum gangense*	-	-	-	+	-	-	-	+	-	-	-	-
17	*Staurastrum bienaeanum* var. *ellipticum*	-	-	-	-	-	-	-	-	-	+	-	-
18	*Staurastrum donardense*	-	-	-	+	-	-	-	+	-	-	-	-
19	*Staurastrum striolatum*	-	-	-	-	-	-	-	+	-	+	-	-
20	*Cosmarium angulatum*	-	-	-	+	+	-	-	-	-	-	-	-
21	*Cosmarium difficile* var. *sublaeve*	-	-	-	-	-	-	-	-	-	-	+	-
22	*Cosmarium granatum* var. *ocellatum*	-	-	-	-	-	-	-	-	-	+	-	-
23	*Cosmarium inaequalipellicum*	-	-	-	-	-	-	-	-	-	-	+	-
24	*Cosmarium lundellii* var. *ellipticum*	-	-	-	+	-	-	-	-	+	-	-	-
25	*Cosmarium maculiforme*	-	-	-	-	-	-	-	-	-	+	-	-
26	*Cosmarium nitidulum*	-	-	-	+	-	-	-	+	-	-	-	-
27	*Cosmarium quadrum* var. *andamanicum*	-	-	-	-	-	-	-	-	-	+	-	-
28	*Cosmarium turgidum* var. *subrotundatum*	-	-	-	-	-	-	-	-	-	+	-	-
29	*Pleurotaenium ehrenbergii*	-	-	-	-	-	-	-	-	-	+	-	-
30	*Micrasterias pinnatifida*	-	-	-	-	-	-	-	+	-	-	-	-
31	*Actinataenium cucurbita*	-	-	-	-	-	+	-	-	-	-	-	-
32	*Stigeoclonium longipilum*	-	-	-	-	+	-	-	-	-	-	-	-
33	*Cladophora glomerata*	-	-	-	-	+	-	-	+	-	-	+	-
34	*Pediastrum tetras*	-	-	-	-	-	-	-	-	-	-	-	+
35	*Pediastrum tetras* var. *tetradron*	-	-	-	-	-	-	-	-	-	-	-	+
36	*Botryococcus braunii*	-	-	-	-	-	-	-	-	-	-	-	+
37	*Scenedesmus armatus* var. *armatus*	-	-	-	-	-	-	-	-	-	-	-	+
38	*Scenedesmus brasiliensis* var. *brasiliensis*	-	-	-	-	-	-	-	-	-	-	-	+
39	*Scenedesmus ellipticum*	-	-	-	-	-	-	-	+	-	-	-	-
40	*Monoraphidium griffithii*	-	-	-	-	-	-	-	-	-	-	+	-
41	*Microspora indica*	-	-	-	-	-	-	-	-	-	-	+	-
42	*Oedogonium tiffanyi*	-	-	+	+	-	-	-	-	-	-	-	-
43	*Oedogonium wyliei*	-	-	+	-	-	-	+	-	-	-	-	-

Sl. No.	Algal taxa	Stream											
		1	2	3	4	5	6	7	8	9	10	11	12
Euglenophyta													
1	*Euglena gracilis*	-	-	-	-	-	-	-	-	-	-	-	+
2	*Phacus pleuronectes*	-	-	-	-	-	-	+	-	-	+	-	-
3	*Trachelomonas bacilifera* var. *minima*	-	-	-	-	-	-	-	+	-	-	-	-
Heterokontophyta(Bacillariophyceae)													
1	*Cyclotella meneghiniana*	-	+	-	-	-	-	-	-	-	-	-	+
2	*Fragillaria virescence*	+	+	+	+	-	-	-	-	-	-	-	-
3	*Synedra tergestina*	+	-	-	+	-	-	-	-	-	-	-	+
4	*Synedra ulna*	+	-	+	+	-	-	-	-	-	-	+	+
5	*Synedra ulna* var. *aequalis*	-	+	-	+	-	+	-	-	-	-	-	-
6	*Synedra ulna* var. *amphirhynchus*	-	-	-	-	+	+	+	-	-	-	-	-
7	*Synedra ulna* var. *oxyrhynchus*	-	-	+	-	-	-	-	-	-	-	-	-
8	*Diatoma pectinale*	-	-	-	-	-	-	-	-	-	+	-	-
9	*Achnanthes coarctata* var. *parallela*	-	-	+	-	-	-	-	-	-	-	-	-
10	*Achnanthes inflata*	-	-	-	-	-	-	-	-	-	-	+	-
11	*Cocconeis pediculus*	+	-	-	+	-	-	-	-	+	-	-	-
12	*Diploneis pullea*	-	-	-	+	-	-	-	-	-	-	+	-
13	*Diadesmis confervacea*	+	-	-	+	-	+	-	-	-	-	+	-
14	*Pinnularia acrosphaeria f. undulata*	-	-	-	-	-	-	-	-	+	-	-	+
15	*Navicula exigua*	-	-	-	+	-	-	-	-	-	-	-	+
16	*Navicula lunata*	+	-	-	-	-	-	+	-	-	+	-	-
17	*Gomphonema micropus*	+	-	-	-	-	-	+	-	-	-	-	-
18	*Gomphonema montanum* var. *genuinum*	-	-	-	-	-	-	-	-	-	+	-	-
19	*Gomphonema parvulum* var. *micropus*	+	-	-	-	-	-	-	-	-	-	-	-
20	*Cymbella affinis*	-	-	-	+	-	-	-	+	-	+	-	-
21	*Cymbella tumida*	-	+	-	-	-	+	-	-	+	-	-	-
22	*Eunotia amphioxys*	-	-	-	-	-	+	-	-	-	-	-	-
23	*Licmophora abreviata*	-	-	+	-	-	-	-	-	+	-	+	-
24	*Himantidium minus*	-	-	-	-	-	-	-	-	-	+	-	-
25	*Amphora veneta*	-	-	-	+	-	-	-	-	+	-	-	-
26	*Nitzschia closterium*	-	-	-	+	-	-	-	-	-	-	-	+
27	*Nitzschia sigmoid*	-	-	-	-	-	-	-	-	-	-	+	-
28	*Nitzschia vasnii*	+	-	-	-	-	-	+	-	-	-	-	+
29	*Surirella euglepta*	-	-	-	-	-	-	-	-	-	-	-	+
30	*Surirella splendida*	-	-	-	+	-	-	-	-	-	-	-	+

Table 3 : Algal taxa recorded from the streams and waterfalls in the Eastern Himalayas and North eastern region of India . Streams of West Bengal: 1- On the way to Tiger hill, 2- Tiger hill, 3- Gangamaya park, 4- Chunnu, 5- Rock Garden; Kalimpong: 6- Deolo, 7- Chitre; Waterfalls in Sikkim: 1- Hanuman tok, 2- Kyongnosola, 3- Banjhagri fall, 4- Pastanga fall, 5- Ranipool, 6- Lachung, 7– Chungthang, 8- Zero point., Streams of Arunachal Pradesh: 1- Sangey, 2 – Jaswantgarh, 3- Doimukh, Streams of Nagaland: 1- Pherem, Streams of Mizoram: 1- Phunchawang, 2- Sairang

Sl.No.	Algal taxa	West Bengal							Sikkim								Arunachal Pradesh			Nagaland	Mizoram	
		1	2	3	4	5	6	7	1	2	3	4	5	6	7	8	1	2	3	1	1	2
1	**Cyanophyta (Cyanoprokaryota/ Cyanobacteria)**																					
	Aphanothece microscopica	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-
2	*Aphanothece saxicola*	-	-	-	-	-	-	-	+	-	-	+	-	-	-	-	-	-	-	-	-	-
3	*Synechocystis pevalekii*	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-
4	*Gloeothece rupestris*	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-
5	*Gloeocapsa crepidinum*	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6	*Gloeocapsa gelatinosa*	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-
7	*Gloeocapsa kützingiana*	-	-	-	-	-	-	-	-	-	-	-	+	+	-	-	-	-	-	-	-	-
8	*Gloeocapsa punctata*	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-
9	*Gloeocapsopsis crepidinum*	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-
10	*Gloeocapsopsis magma*	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-
11	*Cyanosarcina spectabilis*	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	
12	*Chamaesiphon confervicola* var. *elongatus*	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-
13	*Chroococcidiopsis kashayi*	-	-	-	-	+	-	-	-	-	+	-	-	+	-	-	-	-	-	-	-	-
14	*Pseudanabaena limnetica*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-
15	*Geitlerinema lemmermanii*	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-
16	*Spirulina nodosa*	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-
17	*Homoeothrix endophytica*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-
18	*Homoeothrix janthiana*	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-
19	*Homoeothrix varians*	-	-	-	-	-	-	+	-	-	-	+	-	-	-	-	-	-	-	-	-	-
20	*Komvophoron constrictum*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-
21	*Planktothrix suspensa*	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-
22	*Tychonema rhodonema*	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-
23	*Phormidium chlorinum*	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	+	-	-	-	-	-
24	*Phormidium favosum*	+	+	-	-	+	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-
25	*Phormidium granulatum*	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-

26	*Phormidium hamelii*	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-
27	*Phormidium numidicum*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-
28	*Phormidium retzii*	-	-	-	-	-	-	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-
29	*Oscillatoria princeps*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	+	-	-
30	*Oscillatoria yamadae*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-
31	*Lyngbya truncicola*	-	-	+	-	+	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-
32	*Scytonema guyanense*	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-
33	*Scytonema pseudohofmanni*	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-
34	*Calothrix fusca*	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-
35	*Calothrix geitonos*	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-
36	*Calothrix marchica* var. *crassa*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-
37	*Calothrix parietina*	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-
38	*Dichothrix fusca*	-	-	+	+	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-
39	*Dichothrix ledereri*	-	-	-	-	+	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-
40	*Dichothrix orsiniana*	-	-	+	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-
41	*Dichothrix spiralis*	-	-	+	-	-	-	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-
42	*Microchaete uberrima*	+	-	-	-	-	+	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-
43	*Tolypothrix distorta*	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-
44	*Aulosira fertilissima* var. *tenuis*	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-
45	*Nostoc muscorum*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-
46	*Nostoc spongiaeforme* var. *varians*	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
47	*Nostoc commune*	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-
1	**Chlorophyta**																					
	Spirogyra affinis	-	-	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-
2	*Spirogyra esthonica*	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-
3	*Spirogyra hydrodictya*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+
4	*Spirogyra maravillosa*	-	-	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-
5	*Spirogyra parvula*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-
6	*Spirogyra rhizopus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-
7	*Zygnema pseudopunctinatum*	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-
8	*Closterium moniliferum*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-
9	*Cylindrocystis ovalis*	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-

Sl.No.	Algal taxa	West Bengal							Sikkim								Arunachal Pradesh			Nagaland	Mizoram	
		1	2	3	4	5	6	7	1	2	3	4	5	6	7	8	1	2	3	1	1	2
10	*Staurastrum bieneanum* var. *ellipticum*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	-	-	-	-
11	*Cosmarium awadhense*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	-	-	-	-
12	*Cosmarium formosulum*	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-
13	*Cosmarium microsphintum f. parvula*	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-
14	*Cosmarium praecisum*	-	-	-	-	-	-	-	-	-	-	+	+	-	-	-	-	-	-	-	-	-
15	*Cosmarium quadrifarium* var. *oblonga*	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-
16	*Cosmarium radiosum*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-
17	*Coleochaete scutata*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-
18	*Ulothrix tenuissima*	-	-	-	-	-	-	+	-	+	-	-	-	-	-	-	-	-	-	-	-	-
19	*Stigeoclonium curvirostrum*	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-
20	*Stigeoclonium longipilum*	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-
21	*Epibolium polyspermum*	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-
22	*Radiofilum transversalis*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-
23	*Glaucocystis simplex*	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-
24	*Echallocystopsis dichotomus*	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-
25	*Botryococcus protuberans*	-	-	-	-	-	+	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-
26	*Desmodesmus spinosus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+
27	*Scenedesmus bijugatus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-
28	*Scenedesmus ecornis var. ecornis*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-
29	*Scenedesmus pseudopoliensis*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-
30	*Monoraphidium fontinale*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-
31	*Oedogonium chaetophorum* var. *chaetophorum*	-	-	-	-	-	-	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-
32	*Oedogonium pisanum*	-	-	-	-	-	+	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-
33	*Oedogonium radhawae*	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-
34	*Oedogonium wyliei*	-	-	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-
35	*Microspora amoena*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-
36	*Microspora indica*	-	-	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-
37	*Leptosira mediciana*	-	-	-	-	-	-	+	-	+	-	-	-	-	-	-	-	-	-	-	-	-
38	*Phycopeltis epiphyton*	-	-	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-

1	**Heterokontophyta (Bacillariophyceae)**																					
	Melosira varians var. *aequalis*	-	-	-	+	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-
2	*Fragillaria virescens*	-	-	-	-	-	-	+	-	-	-	-	+	+	-	-	-	-	-	-	-	-
3	*Synedra affinis*	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-
4	*Synedra gallionii*	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-
5	*Synedra ulna*	+	-	-	+	+	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6	*Synedra ulna* var. *aequalis*	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	+	-
7	*Synedra ulna* var. *amphirhynchus*	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-
8	*Synedra ulna* var. *oxyrhynchus*	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-
9	*Diatoma mesodon f. quadratum*	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-
10	*Cocconeis pediculus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-
11	*Dploneis subovalis*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-
12	*Achnanthes subsessilis*	-	-	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-
13	*Stauroneis birostris*	-	-	-	-	-	-	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-
14	*Navicula borealis*	-	+	-	-	-	-	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-
15	*Navicula gracilis*	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-
16	*Navicula lanceolata*	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-
17	*Navicula sphaerophora*	-	-	-	-	-	+	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-
18	*Navicula viridis*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-
19	*Navicula viridula*	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	+	-
20	*Gomphonema abbreviatum*	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-
21	*Gomphonema constrictum* var. *capitatum*	+	+	-	-	-	-	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-
22	*Gomphonema elegans* var. *robusta*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-
23	*Gomphonema exiguum*	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
24	*Gomphonema minutissimum*	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-
25	*Gomphonema olivaceum*	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-
26	*Gomphonema telegraphicum*	-	-	-	-	-	-	-	-	-	-	-	-	+	-	+	-	-	-	-	-	-
27	*Cymbella tumida*	+	-	-	+	-	+	+	-	-	+	-	-	-	-	-	-	-	-	-	-	-
28	*Grammatophora undulata*	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-
29	*Nitzschia sinuata* var. *tabelaria*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+
30	*Sphenella angustata*	-	-	-	-	-	-	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-
31	*Epithemia gibberula* var. *producta*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-
32	*Epithemia turgidula*	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-
	+, occurred ; -, did not occur																					

62. ***Surirella splendida** Kütz.; Kützing 1865, p. 62, taf. 7, fig. IX:a-c **(Pl. 4, Fig. 30)**

Frustule solitary, regular, broadly lanceolate to narrow ovate, median raphe present, valve broadly rounded at the base and attenuated towards apex, costae coarse, short, parallel, transverse, striation fine, valve 43-45 µm long, 15 µm broad at base.

Odisha: Huluhula, Ganjam. Epipsammic mat, 20.04.2008, V.N. – 1488.

RESULTS AND DISCUSSION

Twelve mountain streams of Odisha, located in Ganjam, Khurdha, Keonjhar, Balasore, Mayurbhanj, Deogarh, Kalahandi and Bolangir districts, e.g. Panchalingeswar, Devkund, Sitakund, Ghagara, Pradhanpat, Harishankar, Nrushinghanath, Phurlijharan, Barunei, Nirmalajhara, Narayani and Rushikullya stream at Huluhula were surveyed for algal diversity during the period between May 2008 to November 2011 in which 111 species belonging to Chlorophyta, Cyanophyta, Euglenophyta and Heterokontophyta were recorded (Table-2). Of these 12 were recorded from Panchalingeswar (2 Cyanophyta, 1 Chlorophyta and 9 Bacillariophyceae), 7 from Devkund (3 Cyanophyta and 4 Bacillariophyceae), 12 from Sitakund (4 Cyanophyta, 3 Chlorophyta and 5 Bacillariophyceae), 25 from Ghagara (Cyanophyta 3, Chlorophyta 10 and 12 Heterokontophyta), 16 from Pradhanpat (8 Cyanophyta, 6 Chlorophyta and 2 Heterokontophyta), 20 from Harishankar (11 Cyanophyta, 4 Chlorophyta and 5 Heterokontophyta), 11 from Nrushinghanath (Cyanophyta 2, Chlorophyta 4, Euglenophyta 1 and 4 Heterokontophyta), 17 from Phurlijharan (5 Cyanophyta, 10 Chlorophyta, 1 Euglenophyta and 1 Heterokontophyta), 7 from Barunei (1Cyanophyta, 1Chlorophyta and 5 Heterokontophyta), 16 from Nirmalajhara (2 Cyanophyta, 8 Chlorophyta, 1 Euglenophyta and 5 Heterokontophyta), 18 from Narayani (5 Cyanophyta, 7 Chlorophyta and 6 Heterokontophyta) and 28 from Huluhula (9 Cyanophyta, 9 Chlorophyta, 1 Euglenophyta and 9 Heterokontophyta) streams. In 4 of these streams e.g. Nrushinghanath, Phurlijharan, Nirmalajhara and Huluhula one species each of Euglenophyta was recorded indicating the eutrophic status of their water at certain locations which receive organic loading from anthropogenic sources. None of the algal taxa reported in these 12 springs were common between them.

Twenty one mountain springs in the eastern Himalayan region covering West Bengal, Sikkim, Arunachal Pradesh, Nagaland and Mizoram were also surveyed (Table-3). A total of 117 species belonged to Cyanophyta (47), Chlorophyta (38) and Heterokontophyta under Heterokontophyta (32) were recorded. Of these from West Bengal 4 taxa were recorded in a stream on the way to Tiger Hill (1 Cyanophyta and 3 Heterokontophyta), 4 from Tiger Hill (2 Cyanophyta and 2 Heterokontophyta), 11 from Gangamaya park (5 Cyanophyta, 5 Chlorophyta and 1 Heterokontophyta), 4 from Chunnu (1 Cyanophyta and 3 Heterokontophyta), 5 from streams in the Rock garden of Darjeeling (4 Cyanophyta and 1 Heterokontophyta), 5 from Deolo (1 Cyanophyta, 2 Chlorophyta and 2 Heterokontophyta) and 14 from Chitre (3 Cyanophyta, 3 Chlorophyta and 8 Heterokontophyta). In Sikkim 15 species of algae were recorded from Hanuman tok (5 Cyanophyta, 9 Chlorophyta and 1 Heterokontophyta), 6 from Kyngnosola (2 Cyanophyta and 4 Chlorophyta), 4 from Banjhagri fall (1 Cyanophyta, 2 Chlorophyta and 1 Heterokontophyta), 12 from Pastanga (9 Cyanophyta, 2 Chlorophyta and 1 Heterokontophyta), 12 from Ranipool (3 Cyanophyta, 2 Chlorophyta and 7 Heterokontophyta), 27 from Teesta river stream at Lachung (16 Cyanophyta, 4 Chlorophyta and 7 Heterokontophyta), 16 from Chungthang (5 Cyanophyta, 3 Chlorophyta and 8 Heterokontophyta) and 3 from Zero point (1 Cyanophyta, 1 Chlorophyta and 1 Heterokontophyta). In Arunachal Pradesh 8 algal species were documented from Sangey stream (2 Cyanophyta and 6 Chlorophyta), 8 from Jaswantgarh stream (1 Cyanophyta and 7 Chlorophyta), and 2 from Doimukh (1 Cyanophyta and 1 Chlorophyta). From Nagaland six algal taxa from a stream in Pherem (3 Cyanophyta and 3 Heterokontophyta) and in Mizoram 6 from Phunchawang (2 Cyanophyta and 4 Heterokontophyta) and 3 from Sairang (2 Cyanophyta and 1 Heterokontophyta) streams were recorded. In these Himalayan springs also no algal species was common to all these 21 springs. Of the 21 streams, 7 each showed dominance of Cyanophyta, Chlorophyta or Heterokontophyta members (Table- 2).

Analysis of occurrence of algal taxa in 12 streams of Odisha and 21 springs in the Himalayan region covering

West Bengal, Sikkim, Arunachal Pradesh, Nagaland and Mizoram showed that 97 species of algae of which 39 under Chlorophyta, 31 Cyanophyta, 24 Heterokontophyta and 3 Euglenophyta members occurred specifically in the streams in Odisha whereas 103 species of which 43 under Cyanophyta, 34 of Chlorophyta and 26 under Heterokontophyta were confined to springs of the eastern Himalayan region. Of these 97 algal taxa were recoded first from the Eastern region. The commonality of taxa in these thirty three streams showed that only 14 species of which *Phormidium grnulatum, Calothrix fusca, Dichothrix orsiniana, Nostoc commune* under Cyanophyta, *Spirogyra maravillosa, Staurastrum bieneanum var. ellipticum, Stigeoclonium longipilum, Oedogonium wyliei* under Chlorophyta and *Fragillaria virescence, Synedra ulna, Synedra ulna var. aequalis, Synedra ulna var. amphirhynchus, Synedra ulna var. oxyrhynchus, Cymbella tumida* under Heterokontophyta occurred in certain streams of both the regions.

Literature survey showed that a total of 304 algal taxa were reported from 15 streams and waterfalls of different regions of India during the period from 1939-2009. These comprised of 12 Cyanophyta and 15 Heterokontophyta from streams of Ladakh and Bhaderwah, Jammu & Kashmir (Drouet, 1938; Prasad & Jaitly, 1985; Anand & Sharma, 1998), 2 Cyanophyta from a stream of Hoshiarpur, Punjab (Vasishta, 1963), 69 taxa of Heterokontophyta from the streams of Bombay and Lonavla, Maharastra (Gonzalves & Gandhi, 1952; 1962), 52 Heterokontophyta members were from Partabgarh, Rajasthan (Gandhi, 1955), 62 taxa of Heterokontophyta were from streams of Sagar and Jog fall, Karnataka (Gandhi, 1959, 1960), 2 Cyanophytes, 13 Chlorophytes, 2 Euglenophytes and 1 Bacillariophyte from a stream near Chitrapuzha, 70 Heterokontophyta from 2 streams of Pippara in Western ghats, Kerala (Joseph & Joseph, 1999; Pugazhendi *& al* 2009) and 4 Chlorophytes from a stream of Thirumoorthi, Anamalai hill ranges, Tamil Nadu (Sankaran, 2009). These records showed that Heterokontophyta members were dominant in the springs followed by Chlorophytes, Cyanophytes and Euglenophytes. However, the present study revealed that Chlorohyta members were higher in number in most streams followed by Cyanophytes and Heterokontophytes, and those lentic waters located near human habitations also harbour Eugleophyta members due to anthropogenic input.

ACKNOWLEDGEMENTS

We are thankful to the Ministry of Environment and Forests, Government of India, New Delhi for financial assistance through Dr. B.P. Pal National Environmental Fellowship Award project to S.P.A. We thank the authorities of Visva-Bharati, Santiniketan for providing laboratory facilities.

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भारत के पूर्वी एंव उत्तर पूर्वी क्षेत्र की नदियों एवं जल प्रपातों में शैवाल विविधता

एस. भक्ता एवं *एस.पी. अधिकारी*

सार सारांश

उड़ीसा के 12 पर्वतीय नदियों एवं पूर्वी हिमालय क्षेत्र के पश्चिम बंगाल, सिक्किम, अरुणाचल प्रदेश, नागालैंड एवं मिजोरम के 21 जल प्रपातों से 214 शैवाल की जातियों को लिपिबद्ध किया गया है, जिनमें उड़ीसा के नदियों से क्लोरोफाइटा (39), साइनोफाइटा (31), हेटरोकोन्टोफाइटा (24) एवं यूग्लीनोफाइटा (3) विशेष रूप से लिपिबद्ध किये गये हैं एवं शेष साइनोफाइटा (43), क्लोरोफाइटा (34) एवं बेसीलेरियोफाइटा (26) पूर्वी हिमालय क्षेत्र की नदियों एवं जलप्रपातों से प्राप्त किये गये हैं। पूर्वी भारत के इन दो क्षेत्रों में शैवाल की विविधता स्थालकृति व जलवायु में अंतर है, जो इस विशिष्ट एवं प्रायः अप्रदुषित प्राकृतवासों में टैक्सा की प्राप्ति में व्यापक परिवर्तन दर्शाता है। केवल 14 जातियाँ जिनमें *साइनोफाइटा* कुल के *फौरमिडियम ग्रेनुलेटम, कैलोथ्रिक्स फुसिया, डाइकोथ्रिक्स ओरसिनियाना, नास्टाक कामिनाई,* अंतर्गत *क्लोराफाइटा* के अंतर्गत *स्पारोगायरा, मराबिलोरसा, स्ट्ररेस्टम, बिनियेनम* प्रभेद *इल्पिटिकम, स्टीग्यिों क्लेनियम, लोंगीफाइलम, ओडोगोइनम, नाइलाइ* एवं *फैगिलेरिया विरेसन्स, सेन्ड्राउल्ना* प्रभेद *एक्वेलिस, सैन्ड्राउल्ना* प्रभेद *एक्वेलिस, सैन्ड्राउल्ना* प्रभेद, *आक्सीरेंचस, सिमबेल्ला, टुमिडा, बेसिलेरियोंफाइसी* के अंतर्गत हेट्रोनोटोफाटा के अंतर्गत हेट्रोनोटोफाइटा वर्ग के दोनों क्षेत्र से लिपिबद्ध किये गये हैं। 214 शैवाल टैक्सा में से 97 पूर्वी एवं उत्तर पूर्वी क्षेत्र से प्रथम बार लिपिबद्ध किये गये हैं।